UNIVERSITY OF JOHANNESBURG

COPYRIGHT AND CITATION CONSIDERATIONS FOR THIS THESIS/ DISSERTATION

- Attribution — You must give appropriate credit, provide a link to the license, and indicate if changes were made. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.
- NonCommercial — You may not use the material for commercial purposes.
- ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original.

How to cite this thesis

Surname, Initial(s). (2012). Title of the thesis or dissertation (Doctoral Thesis / Master's Dissertation). Johannesburg: University of Johannesburg. Available from: http://hdl.handle.net/102000/0002 (Accessed: 22 August 2017).

THE RELATIONSHIP BETWEEN WATER QUALITY AND DIARRHEOAL DISEASES IN CHILDREN UNDER-FIVE YEARS OF AGE IN MADLENYA COMMUNITY, ESWATINI

University of Johannesburg

Faculty of Health Science

Master of Public Health (MPH) Masters Dissertation

Vusi Mthulisi Ndzinisa

Student Number: 218100015

Supervisor: Professor Shingairai Feresu

UNIVERSITY OF JOHANNESBURG

_____ **04/01/2021**

Supervisor: Professor Shingairai Feresu **Date**

Declaration

I, Vusi Ndzinisa would like to state that this dissertation is the result of my investigation and it has not been submitted previously to any learning institution in part or in full for any degree.

I confirm that:

1. This dissertation was done while in candidature for a Master of Public Health degree at University of Johannesburg, Republic of South Africa.

2. Where, I have consulted the work of other authors and publishers the, work is cited.

30/07/2020

…… ……

Date **Vusi Ndzinisa**

UNIVERSITY OF JOHANNESBURG

Dedication

This work is dedicated to my lovely wife Mrs. Nomfundo Ndzinisa, my sons Mhlelisi, Mcebisi and my Niece Senzelwe Vilakati who provided an enabling and comfortable environment for me to prepare this document, and I want you to know that you have contributed immensely to my career and you are highly appreciated. I invite God to be with us as I climb the educational ladder.

Moreover, special thanks should go to my father Mr. H. Ndzinisa and my late mother LaShabangu for laying a good foundation of education for me. Without you I could not have grown to the person, I am today. I will always follow your advice and directions.

Thank you once again.

UNIVERSITY
OF
JOHANNESBURG

Acknowledgements

First, I would like to thank God for the opportunity He has provided me to pursue a Masters of Public Health.

I would like to express my sincere gratitude to my supervisor Professor S. Feresu, University of Johannesburg who has provided guidance and support in the development of this dissertation. Your kind and tireless guidance is remarkable, and I have learnt a lot from you and thank you very much.

I would also like to thank my employer the Ministry of Health for granting me permission to study this course, it is my hope that the knowledge obtained will be useful in improving my performance at work and contributing to the department's core mandate.

Lastly but not least I would like to thank my colleagues for their support and company, indeed I have enjoyed studying with you.

UNIVERSITY OF JOHANNESBURG

Abstract

Background: The Government of the Kingdom of Eswatini is a signatory to the United Nations and therefore joined members to pledge reduction of extreme poverty by adopting the Sustainable Development Goals (SDGs) in 2016. The Ministry of Health through the Environmental Health Department promotes, among other things, water, sanitation and hygiene which are in line with fulfilling goal number 6 of the SDGs. This research study seeks to assist the Ministry of Health to fulfill the Sustainable Development Goals listed above through the collection of country specific data on diarrheoal diseases. The study was conducted at Madlenya community in the Lubombo region.

Methods: The research is a cross sectional analytical study with a predesigned questionnaire administered to parents or guardians of children under-five years of age at Madlenya community. The study collected and analyzed six-month retrospective data on diarrheoal diseases in children at Madlenya. Diarrheoa clinical history of children, water transportation, storage practices, water treatment and socio-demographic data was collected using a pre-designed questionnaire and analyzed to ensure that the relationship between water quality and diarrheoal diseases in children is well comprehended. The questionnaire was pre-tested before being administered to parents/guardians of children to ensure validity and reliability.

Results: In total, there were 391 parents/guardians interviewed in the study, 224 children had been diagnosed with diarrheoal diseases during the 6 months' study period and, 167 had no diarrheoal diseases. Out of the 224 children with diarrheoal diseases, 106 children had watery diarrheoa and 118 had bloody diarrheoa, which are some of the symptoms associated with Rotavirus and Dysentery respectively. The period prevalence of diarrheoal diseases at Madlenya was calculated to be 57.27 per 100 children. Parents/guardians utilizing river and unprotected dug well were 8.20 and 9.60 times respectively likely to have children with diarrheoal diseases with odds ratios (COR: 8.20; 95% CI 2.79 – 24.11) and (COR: 9.60; 95% CI 2.94 – 31.30) indicating statistically significant results with unprotected dug well with a more likely adjusted odds ratio of (AOR: 2.88; 95% CI 1.50 – 5.55).

Conclusion: It can be concluded from the study that poor hygiene, absence of sanitary facilities, poor water treatment methods, are a major contributing factor to diarrheoal diseases and water contamination in children under-five years of age.

KEYWORDS

Diarrheoa, Rotavirus, Dysentery, Children, Water Treatment, Parents/Guardians.

UNIVERSITY OF JOHANNESBURG

TABLE OF CONTENTS

Declaration..... i
Dedication..... ii
Acknowledgements..... iii
Abstract..... iv
Table of Contents..... v
List of Abbreviations..... viii
Glossary..... ix
List of Figures..... x
List of Tables..... xi

CHAPTER 1: INTRODUCTION..... 1
1.1 Introduction..... 1
1.2 Background Information..... 2
1.2.1 *Water and Sanitation Policy Environment in Eswatini*..... 3
1.3 Problem Statement..... 5
1.4 Research Questions..... 7
1.5 Overall Objective..... 7
1.5.1 Specific Objectives..... 7
1.6 Overall Hypothesis..... 8
1.6.1 Specific Research Hypothesis..... 8
1.7 Significance of research study..... 8
1.8 Study Feasibility..... 9
1.9 Purpose of the Study..... 10
1.10 Research Delimitation..... 10
1.11 Conclusion..... 10

CHAPTER 2: LITERATURE REVIEW..... 12
2.1 Introduction..... 12
2.2 Health belief Conceptual Framework..... 12
2.3 Literature Search Strategy..... 14
2.4 Literature Review..... 14
2.4.1 *Rotavirus and Dysentery*..... 15
2.4.2 *Drinking Water and Sanitation*..... 16
2.4.3 *Water Quality*..... 17
2.4.4 *Government Interventions and Challenges*..... 17
2.4.4 *Similar Studies*..... 18
2.5 Conclusion..... 20

UNIVERSITY OF JOHANNESBURG

CHAPTER 3: STUDY DESIGN AND METHODOLOGY 21
3.1 Study Design 21
3.2 Study Area 21
3.3 Study Population 22
3.4 Sampling Strategy 22
3.5 Sample Size Estimation 23
3.6 Inclusion Criteria 24
3.6.1 Parents/Guardian of children 24
3.6.2 Child's Clinical History symptoms 24
3.7 Exclusion in the study 24
3.8 Type of Data 24
3.8.1 *Primary Sources of Data* 24
3.8.2 *Secondary Sources of Data* 25
3.9 Data collection Concepts and Techniques 28
3.10 Pilot Study 29
3.11 Reliability 30
3.12 Validity 30
3.13 Data Analysis 31
3.13.1 *Data Analysis for each Objective* 31
3.14 Ethical Consideration 32
3.14.1 Informed Consent 32
3.14.2 Beneficence 32
3.14.3 Justice 33
3.14.4 Autonomy 33
3.15 Limitations of the Study 33
3.16 Strengths of the Study 34
3.17 Public Health Implications 34
3.18 Possible Outcomes 34

CHAPTER FOUR: RESULTS AND INTERPRETATION 36
4.1 Introduction 36
4.1.1 Research Questions 38
4.2 Demographic Data Frequency Distribution 39
4.3 Frequency Distribution by symptoms associated with Rotavirus and Dysentery 40
4.4 Crude and Odds ratios by demographic Factors 42
4.5 Frequency Distribution by Water and Sanitation Factors 43
4.6 Crude and Odds Ratios by Water and Sanitation Factors 45
4.7 Frequency Distribution of Participants by Hygiene Practices 46
4.8 Crude and Odds Ratios by Hygiene Practices 47

UNIVERSITY OF JOHANNESBURG

4.9 Frequency Distribution by knowledge of Diarrheoal diseases..... 48
4.10 Crude and Odds Ratios by knowledge of Diarrheoal diseases..... 50
4.11 Conclusion.....50

CHAPTER 5: DISCUSSIONS AND RECOMMENDATIONS.....51
5.1 Introduction.....51
5.2 Study objectives.....51
5.3 Main Findings.....51
5.3.1 Demographics.....52
5.3.2 Water and Sanitation.....53
5.3.2.1 Water Quality.....53
5.3.2.2 Water quality and Diarrheoal Diseases 53
5.3.2.3 Water treatment.....54
5.3.2.4 Sanitation.....55
5.3.3 Hygiene Practices.....55
5.3.4 Diarrheoal Diseases Knowledge.....56
5.4 Research Limitations.....56
5.5 Strengths of the study.....57
5.6 Public Health Implications.....57
5.7 Research Contributions.....57
5.8 Recommendations.....58
5.9 Conclusions.....59
References.....60

Appendices.....64
Appendix 1: Higher Degree Committee Approval Letter.....66
Appendix 2: Research Ethical Committee approval letter.....67
Appendix 3: Study Area Approval Letter.....68
Appendix 4: Research Questionnaire.....69
Appendix 5: Research consent form 74
Appendix 6: Information Letter.....75
Appendix 7: Editor Certificate.....78
Appendix 8: Turnitin Certificate.....79
Appendix 9: Timeline for the Study.....80
Appendix 10: Budget.....81

UNIVERSITY OF JOHANNESBURG

LIST OF ABBREVIATIONS

Abbreviation	Explanation
CDC	Centre for Disease Control and Prevention
MICS	Multiple Indicator Cluster Survey
DHS	Demographic Health Survey
E.Coli	Escherichia Coliform
EHCP	Essential Health Care Package
EWSC	Eswatini Water and Services Cooperation
KM	Kilometres
SDGs	Sustainable Development Goals
SAM	Service Availability Mapping
RHM	Rural Health Motivators
WHO	World Health Organization
MOH	Ministry of Health
NGO	Non-Governmental Organization
UNICEF	United Nations International Children's Emergency Fund
SPSS	Statistical Package for the Social Sciences
WASH	Water Sanitation and Hygiene
CFU's	Colony Forming Units
VIP	Ventilated improved Pit

UNIVERSITY OF JOHANNESBURG

GLOSSARY

Term	Definition
Diarrheoa	Abnormal passing of stool at least more than 3 times in a day either mucous, bloody, watery or water-wash like.
Dysentery	Diarrheoa in which there is blood, pus, and mucous, usually accompanied by pain.
Sanitation	Condition relating to public health, especially the provision of clean drinking water and adequate sewage disposal.
Improved Water Facilities	These facilities include piped water supply, public taps/standpipes, and boreholes, protected dug wells, protected spring and protected rain catchment.
Rotavirus	Genus of double stranded RNA viruses in the family Reoviridae and the most cause of diarrheoal diseases in children
Fecal coli form	Microscopic bacteria that live in the intestines of warm-blooded animals.
Infant mortality rate	The number of deaths per 10000 live births of children under 1 year of age.
Improved Sanitation Facilities	Facilities that ensure hygienic separation of human waste from human contact. These include flush pour flush toilets, ventilated improved pit latrine; pit latrine with slab; and composting latrines.
Morbidity	Case of a particular disease
Tippy-Tap	The Tippy Tap is a simple device for hand washing with running water and soap.

UNIVERSITY OF JOHANNESBURG

LIST OF FIGURES

Figure 1: Structure of the Health Delivery System.....5
Figure 2: Health Belief Conceptual Framework 12
Figure 3: Water and Sanitation Coverage Bar Graphs.....16
Figure 4: Study Area Satellite View Map.....21
Figure 5: Sample size Estimation Using EPINFO 7.2.....23
Figure 6: Age Group Frequency Distribution.....36
Figure 7: Gender of Children Frequency Distribution.....37
Figure 8: Level of Education Frequency Distribution.....37

UNIVERSITY OF JOHANNESBURG

LIST OF TABLES

Table 1: Dependent and Independent Variables..... 25
Table 2: Frequency Distributions by demographic factors..... 38
Table 3: Frequency Distribution by Symptoms associated with Rotavirus and Dysentery..... 39
Table 4: Crude and Adjusted Odds Ratios by Diarrheoal diseases..... 41
Table 5: Frequency Distributions by Water and Sanitation factors..... 42
Table 6: Crude Odds Ratios and Adjusted Odds ratios by Water and Sanitation Factors..... 44
Table 7: Frequency Distribution by Hygiene Practices..... 45
Table 8: Crude Odds Ratios (COR) and Adjusted Odds Ratios (AOR) of study According to hygiene practices..... 46
Table 9: Frequency Distribution by Knowledge of diarrheoal diseases..... 47
Table 10: Crude Odds Ratios (COR) and Adjusted Odds Ratios (AOR) of study Participants according to knowledge of Diarrheoal diseases..... 49

UNIVERSITY OF JOHANNESBURG

CHAPTER 1: INTRODUCTION

1.1 Introduction

Children represent the future and ensuring their healthy growth and development ought to be the prime concern of all societies. According to the Eswatini Ministry of Health (2019), its main mission is to improve the health of the people of Eswatini by providing leadership in the production, delivery and utilization of health services which will consistently increase longevity and quality of life. However, in recent years, there has been an increase in the number of diarrheoal diseases in the country especially those that affect children under-five years of age, and this threatens the reason for existence of the Ministry of Health.

A Rotavirus disease outbreak in 2014 claimed the lives of 36 children mostly under-five years of age in the country. According to the Ministry of Health (2019) First Quarter performance report from January to May, there were 20204 cases of children under-five years with diarrheoal diseases. These outbreaks and deaths of children indicate that diarrheoal diseases are among the most common causes of morbidity and mortality in Eswatini especially for children. Surprisingly, there has been limited studies conducted in the country to ascertain the cause of diarrheoal diseases in children, instead it is commonly hypothesized that poor sanitation and drinking water quality are the main causes of diarrheoal diseases in children. Thus, the study ventured to determine the relationship between water quality and diarrheoal diseases in children at community level, after which data obtained hopefully will be representative of the situation at regional and country level.

The study utilized both descriptive and analytical methods to collect and analyze data from samples taken from Madlenya community. A questionnaire (see appendix 4) was designed, pretested and administered to parents/guardians of children and water samples from the community water sources were collected and analyzed. Water samples were tested for *Esherichia Coli* which was used as an indicator of the microbial quality of water in the study. Through the consent from parents/guardians, each child's clinical history of diarrheoal diseases was obtained from immunization card to determine diarrheoa symptoms mainly watery diarrheoa and bloody diarrheoa which were associated with Rotavirus and Dysentery in the study. Diarrheoal diseases in the context of the study combined children who had been diagnosed with watery diarrheoa, which presents as watery stool with no blood and mucus, and bloody diarrheoa which presents as

UNIVERSITY OF JOHANNESBURG

a mucoid stool that may be accompanied by blood. In addition, water transportation, storage practices and treatment were studied to determine water quality utilized by children under-five years. This ensured that the relationship between water quality and diarrheoal diseases in children is well understood.

1.2 Background

According to Levy (2015), it is almost 150 years since John Snow closed the Broad Street pump after a cholera outbreak and thereby initiated the debate on diarrheoal disease risk factors and their elimination. WHO (2017b) stated that diarrheoal diseases are the second leading cause of death in children under-five years, and is responsible for the global death of 525 000 children annually, and there are nearly 1.7 billion childhood diarrheoa cases reported yearly. One of the contributing factors to high mortality of diarrheoa in children is their vulnerable immune system as it is still developing (Mokomane et al., 2018). There are a number of factors contributing to diarrheoal diseases in children and the study seeks to determine if there is a relationship of the factors with water quality.

The University of Rochester Medical Center (2018) explained that Rotavirus is a contagious virus that can cause nausea and acute watery diarrheoa in children. Most children contract the virus between the ages of 3 months and 35 months and infections are more common in the cooler months of the year. CDC (2019b) stated that, Rotavirus disease is most common in infants and young children, sometimes, older children and adults can get sick from Rotaviruses. Adults who have Rotavirus disease tend to have milder symptoms. WHO (2018a) concurred that Rotaviruses are the most common cause of severe diarrheoal diseases in children throughout the world and the most common symptoms of Rotavirus are acute watery diarrheoa, vomiting, fever, and abdominal pains. CDC (2018) state that the virus may be found in water sources such as wells, rivers, unprotected springs that have been contaminated with the feces from infected humans. Waste can enter the water through different ways, including sewage overflows, sewage systems that are not working properly, open defecation, and polluted storm water runoff.

Khalili (2014) explained that, WHO described dysentery as any episodes of diarrheoa in which, there is blood in loose and watery stool and dysentery is major cause of childhood morbidity and mortality, especially in developing countries in Africa, Asia and Central America. Most dysentery

UNIVERSITY OF JOHANNESBURG

cases in tropical areas are caused by *Shigella.* The symptomatic difference between the two diseases is the presence of blood in episodes of diarrhea in Dysentery. The study used this symptomatic difference to determine chances of children who had been diagnosed with diarrheoal diseases to have had Dysentery or Rotavirus during the study period.

Water safety and quality are fundamental to human development and well-being, and the importance of water quality relative to other risk factors in the causation of diarrheoa has long been a point of discussion among epidemiologists, public health experts and engineers in the water sector. Providing access to safe water is one of the most effective instruments in promoting health and reducing poverty (WHO, 2017b). Water quality analysis is one of the most important aspects in drinking water studies as stated by Singh and Shrivastava (2015) and the quality of river water according to Jensen (2004) is highly driven by the catchment area activities, particularly where the water is used for domestic purposes by downstream users. The study focused on the relationship between water quality and diarrheoal diseases in children under-five years and to what extent the relationship contributes to diarrheoal diseases in children.

To determine the quality of water used by study participant, water samples from water sources at Madlenya were laboratory analyzed for Fecal coliform count. According to Vilane and Tembe (2016), Fecal Coliforms are defined as the group of total coliforms that are able to ferment lactose at 44 - 45°C. They comprise the genus Escherichia and, to a lesser extent, species of *Klebsiella, Enterobacter,* and *Citrobacter*. Out of these organisms, only *Escherichia Coli* is considered to be specifically of fecal origin, being always present in the feces of humans, other mammals and birds in large numbers and rarely, if ever, found in water or soil in temperate climates that has not been subjected to fecal pollution. It is for this reason that for fecal coliform count in the study *E. Coli* will be used as a microbial indicator of water quality.

1.2.1 Water and Sanitation Policy Environment in Eswatini

Water and Sanitation are known to be major contributing factors to diarrheoal diseases, and poor sanitation can be responsible for the microbial contamination of water sources. Eswatini has put in place policies to improve on water and sanitation to reduce mortality. First, The Eswatini Poverty Reduction Strategy and Action Plan (PRSAP, 2007) recognizes that poor water access and sanitation as a social characteristic associated with poverty, needs to be addressed as a matter of

urgency. In addition, Eswatini has a Draft National Water Policy that commits the country to a social, moral and economic responsibility to ensure that all its citizens have adequate access to safe water and adequate sanitation to guarantee human dignity to health (Eswatini Draft Water Policy, 2007). According to the Multiple Indicator Cluster Survey (2010), sanitary means of disposal in Eswatini may include septic tanks, pits, a dry latrine, and bucket latrines, a pour flush latrine, or facilities that empty into a sewerage system. Sanitation coverage is estimated at between 59%-63% for the country. In rural areas, the situation is worse than urban settings with only 46% sanitation coverage mainly due to low socioeconomic status of the majority of rural population., According to Eswatini Government (2019), Eswatini have a Water, Sanitation and Hygiene (WASH) forum which comprises of organizations, institutions and citizens who have an interest in water supply, sanitation and health initiatives and membership is voluntary. The objectives of the forum include; awareness rising on WASH issues; enhancement of networking and sharing of best practices amongst stakeholders, and to monitor implementation of WASH projects by member organizations.

Furthermore, the government of the Kingdom of Eswatini through the Ministry of Health adopted a National Health Sector Strategic Plan (2008) and the targets for this include among others increasing improved sanitation facilities from 52% to 80%, and increase safe waste disposal including human excreta facilities from 25% to 60% of households and disease prevention. Moreover, the Ministry has adopted guidelines on water, sanitation and hygiene promotion to be implemented by government and its partners through mobilization on communities to support and participate in related interventions.

Lastly, Regional Health Teams at regional level work together with government development partners to decentralize and implement the sanitation interventions. The regional teams scale up regional interventions at target areas by ensuring that more households have access and utilize appropriate sanitation facilities, and they ensure communities have increased knowledge on basic hygiene and sanitation, water use and storage.

UNIVERSITY OF JOHANNESBURG

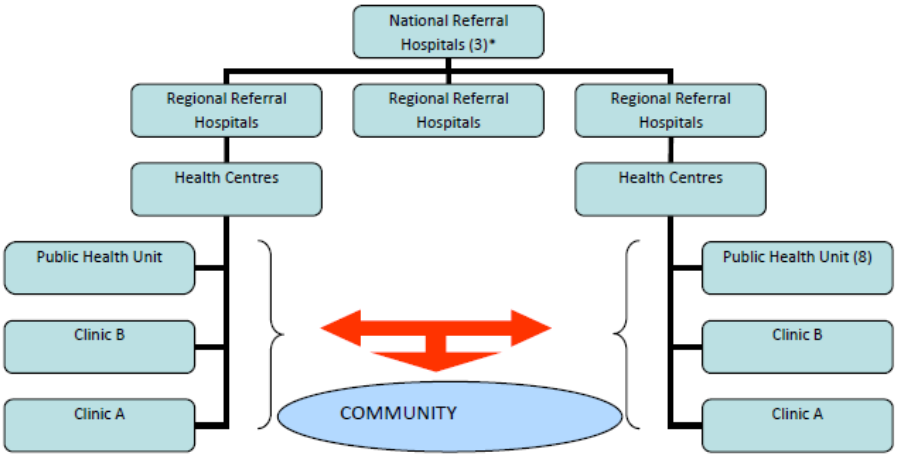


Figure 1: Shows the Structure of the health service delivery system *(Service availability Mapping. 2014)*

The Ministry of Health operations are guided by the National Health Policy 2007 and it is currently under review. It shapes the strategic direction of the ministry and outlines the structural and legislative organs that will guide and regulate the implementation and delivery of health services at national and regional levels. The service delivery systems are delivered through a decentralized system from the central ministry to the four regions of the country namely Hhohho, Manzini, Lubombo and Shiselweni. The central level performs executive and administrative functions as well as providing strategic guidance on delivery of the Essential Health Care Package (EHCP) at all service delivery levels.

UNIVERSITY OF JOHANNESBURG

1.3 Problem Statement

According to the Central Statistics Office (2017) Population and Housing Census Preliminary Result Report, the Kingdom of Eswatini has an estimated population of 130208 children in the age group of the 0-5 years. In 2019, the Centers for Disease and Infection Control (CDC, 2019a) indicated that diarrheoal diseases were among the top 10 causes of death in Eswatini's general population. According to the Ministry of Health (2018) annual performance report, 1073 children less than 5 years of age were attended at Sithobela Health Centre alone for diarrheoal related sickness. All Africa (2018) consistently stated that, a national outbreak of diarrheoa attributed to Rotavirus killed at least 36 children under-five years in Eswatini in 2014. The Kingdom of Eswatini Government (2016) Multiple Indicator Cluster Survey report also indicated that the

situation was further worsened by a drastic decline in the sanitation coverage both in urban and rural areas in Eswatini. This decline led to the increase in diarrheoal diseases in the country especially in children and those that are immune- compromised. This evidence suggests an increase in mortality and morbidity due to diarrheoal diseases in children especially under-five years, which prompted the study to research the contributing factors to diarrheoal diseases.

More appalling is that there have been no noticeable efforts by government to conduct research to combat diarrheoal diseases and reduce mortality. In July 2019, the Ministry of Health (2019) Second Quarter Performance Report reported that there were 60 cases were attended in OPDs in children under-one-year-old. In the spirit of promoting access to health services, WHO as stated by the Kingdom of Eswatini Government (2014) Service Availability Mapping report recommends a walking distance of five kilometers to the nearest health facility. The diarrheoal situation in children is also worsened by the fact that, currently up to 85% of the population lives within eight kilometers of a health facility according to Kingdom of Eswatini Government (2014) Service Availability Mapping report which is much more than the recommended 5 km by World Health Organization. This indicates a gap in the country's health system which directly contributes to increased mortality in children with diarrheoa due to delayed treatment. The situation is further compounded by the fact that the allocation of health resources tends to favor urban populations over rural ones, thus rural communities are left without healthcare services (the Kingdom of Eswatini Government (2018) Master Plan towards the Elimination of Neglected Tropical Diseases. This result in the increase of morbidity and mortality associated with diarrheoal diseases and other diseases in children in the country.

Madlenya community has also been affected by the increase in diarrheoal diseases, as it is located in the rural areas of the country. Siphofaneni Clinic outpatient register has been indicating an increase in the number of diarrheoal disease cases at Madlenya and surrounding communities. According to WHO (2017a) the majority of rural communities in the country rely on communal water taps, rivers and wells as a source of drinking water and most of the rural population relieve themselves in either pit latrines or practice open defecation in the bushes and have no access to running water, which is also known to be a contributing factor to diarrheoal diseases in children.

UNIVERSITY OF JOHANNESBURG

The increasing child mortality due to diarrheoal diseases has been a major concern for the country and has prompted the researcher to conduct the study to generate data that can be used to reduce mortality. The threat from diarrheoal disease in the country needs urgent attention thus the study findings may aid in providing data that can be used to combat diarrheoal diseases in children. Children are supposed to be the future of the country and the emotional scars, financial drain and social impact to their parents and relatives due to diarrheoal diseases could impact negatively their future (Sumampouw, Nelwan and Rumayar, 2019).

1.4 Research Questions

1) What is the relationship between diarrheoal diseases and children under-fives years of age at Madlenya community?
2) What is the relationship between diarrheoal diseases in children under-fives years and drinking contaminated water in Madlenya?
3) What practices impact water quality negatively and the relationship between water quality and diarrheoal diseases at Madlenya.

1.5 Overall Objective

The overall aim of this study is to determine the relationship between diarrheoal diseases, and water quality.

UNIVERSITY OF JOHANNESBURG

1.5.1 Specific Objectives

1. To examine the relationship between diarrheoal diseases and children under-five years of age at Madlenya community.
2. To investigate the relationship between diarrheoal diseases in children under-five years and drinking contaminated water at Madlenya.
3. To determine practices that impact water quality and the relationship between water quality and diarrheoal diseases in children under-five years at Madlenya.

The findings that will be obtained from the study will contribute to informing planning and policy making on prevention and management of diarrheoal diseases in the country. At community level, the study findings will be used assist Madlenya community to comprehend their water quality status, diarrheoal diseases prevalence and come-up with community specific interventions.

1.6 Overall Hypothesis

Drinking water that is of poor quality is likely to increase the prevalence of diarrheoal diseases in households with children under-five years of age at Madlenya.

1.6.1 Specific Research Hypothesis

1. To examine the relationship between diarrheoal diseases and children under-five years of age at Madlenya community.

   Null hypothesis: There is no association between diarrheoal diseases and children under-five years of age at Madlenya community.

   Alternative hypothesis: There is an association between diarrheoal diseases and children under-five years at Madlenya community.
2. To investigate the relationship between diarrheoal diseases in children under-fives years and drinking water that is of poor quality at Madlenya.

   Null hypothesis: There is no relationship between diarrheoal diseases in children under-fives years and drinking poor quality water.

   Alternative hypothesis: There is a relationship between diarrheoal diseases in children under-fives years and drinking poor quality water.
3. To determine practices that impact water quality and the relationship between water quality and diarrheal diseases in children under-five years at Madlenya.

   Null hypothesis: There is no difference between bad and good practices that impact water quality in households with children under-five years at Madlenya.

   Alternative hypothesis: There is a difference between bad and good practices that impact water quality in households with children under-five years at Madlenya.

1.7 Significance of the Study

The study of the relationship between water quality and diarrheoal diseases seeks to provide useful data and information that can be utilized by the Ministry of Health especially the Environmental Health Department in achieving its core mandate of preventing the spread of communicable diseases. The Ministry of Health will be able to formulate informed policies and decision making on the prevention of the spread of diarrheoal diseases in children. Country specific data on the

UNIVERSITY OF JOHANNESBURG

relationship between water quality and diarrheoal diseases will be generated by the study thus enabling country specific sustainable solutions to reduce the mortality resulting from diarrheoal diseases in children. In addition, the information gaps on the factors contributing to diarrheoal diseases in children especially under-fives years in the country will be explored and filled.

The study findings will also raise awareness on the importance of water quality and the relationship with diarrheoal diseases in children in Madlenya community. The community will benefit from knowing the quality of their water as the study will map their sources and test their water quality. They can use the findings to initiate measures explore locally available water treatment options to improve their water quality. The study results will also provide a basis for seeking assistance from non-profit making organizations, government and implementing partners to combat diarrheoal diseases. In addition, parents or guardians of children sampled for the study will be sensitized on domestic water treatment options, and they will be able to distinguish the different types of diarrheoa in children. Overall, the study will aid parents of children, community, regions and the whole country to plan on the prevention of the spread of diarrheoal diseases especially in children.

1.8 Study Feasibility

The feasibility of the study is an assessment of the practicality of conducting the study. The feasibility of the study was confirmed on the basis that the location of the study area was within the demarcations of the researcher's employment catchment area and it fell within the areas serviced by Siphofaneni Clinic. Community entry into the study areas was not complicated as a number of water and sanitation projects, outreach services have previously been initiated and implemented by the Environmental Health Department adjacent to the study area. Furthermore, the households in the study area are clustered together (with a few exceptions) thus, movements during the data collection exercise was minimal thus saving costs. Moreover, the study area is located in close proximities with Siphofaneni town, thus organizing resources and planning logistics for the study was simplified, such as venue for training data collectors, printing stationery and transport. One of the challenges in the study was the unavailability of a water-testing laboratory at Siphofaneni, thus water samples had to be transported to Mbabane which is about 70km from the study area. However, transport was timely organized to transport water samples for laboratory analysis. Recommendations from the study will be submitted to the Ministry of Health

UNIVERSITY OF JOHANNESBURG

for consideration in order to improve the health of children in the country especially in the prevention of diarrheoal diseases.

1.9 The Purpose of the Study

The primary concern of the study is to determine whether there is a relationship between diarrheoal disease in children under-five years and water quality, which is the measure of the condition of water relative to the requirements to any human needs. The study also seeks to provide baseline data regarding childhood diarrheoal diseases for the Ministry of Health and study community and comprehensively reflect the current existing situation in the country. Knowledge and beliefs of parents of children will be explored to provide a better picture of the situation in communities regarding diarrheoal diseases.

Data collected will assist the Ministry of Health, the study area and the researcher to make informed decisions on how to prevent the spread of diarrheoal disease particularly in children. This can be achieved, as the study seeks to provide information that is currently unavailable especially in Eswatini on the relationship between water quality and diarrheoal diseases. The unavailability of such data has led to an increased mortality rate of children under-fives due to diarrheoal diseases.

1.10 Research Delimitation

UNIVERSITY OF JOHANNESBURG

The study was delimited to Madlenya community which situated on the outskirts of Siphofaneni town. Parents/guardians of children from the community were interviewed using a predesigned questionnaire. Parents or Guardians of children had to be with children included in the study for a period of six months to know their clinical history. Madlenya community has been identified by the researcher as the ideal area to conduct the study and to represent rural areas of the country. A number of factors such as climatic conditions, socio-demographic factors, water and sanitation coverage were considered in the selection of the study area.

1.11 Conclusion

The chapter provided a theoretical background of the study. Objectives of the study were outlined which determined the scope depth and overall direction of the research study. After the objectives, the research questions listed the main questions the research study seeks to answer. The research

problem statement detailed the problem perceived on diarrheoal diseases in the country as well as at Madlenya community. The justification of the study is that there is re-occurrence of diarrheoal diseases especially in children in the country, thus the study seeks to provide the necessary information to combat diarrheoal diseases. The significance of the study is that, with the data collected the will provide the Ministry of Health with information that can be used to formulate informed policies on the prevention of diarrheoal diseases in children. The study rationale is that, although studies have been conducted on contributing factors to diarrheoal diseases in children in other countries, such information that gives an in-depth analysis in the context of Eswatini is lacking.

UNIVERSITY
OF
JOHANNESBURG

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

As a scientific investigation, in order for a research to succeed in new conclusions and establish facts, it should build on existing data. The literature review highlights towards the various previously conducted research on diarrheoal diseases in children. There was a review of different literatures to spot gaps and determine the study's present place within the research field. Literature on diarrheoal diseases in children provided relevance, coherence and ways in which the analysis of the findings of the study can be conducted. Literature was reviewed from journal articles, books, newsletters, locally and international. Reviewing literature generated in the country aided to determine strides taken to combat diarrheoal diseases.

2.2 Health Belief Conceptual Framework

The framework has identified a number of factors from literature review such as cultural beliefs, lack of knowledge, hygiene and sanitation, contaminated water sources and the socioeconomic status as some of the contribution factors to diarrheoal diseases in children. The conceptual framework forms a network of interlinked factors towards behavior change.

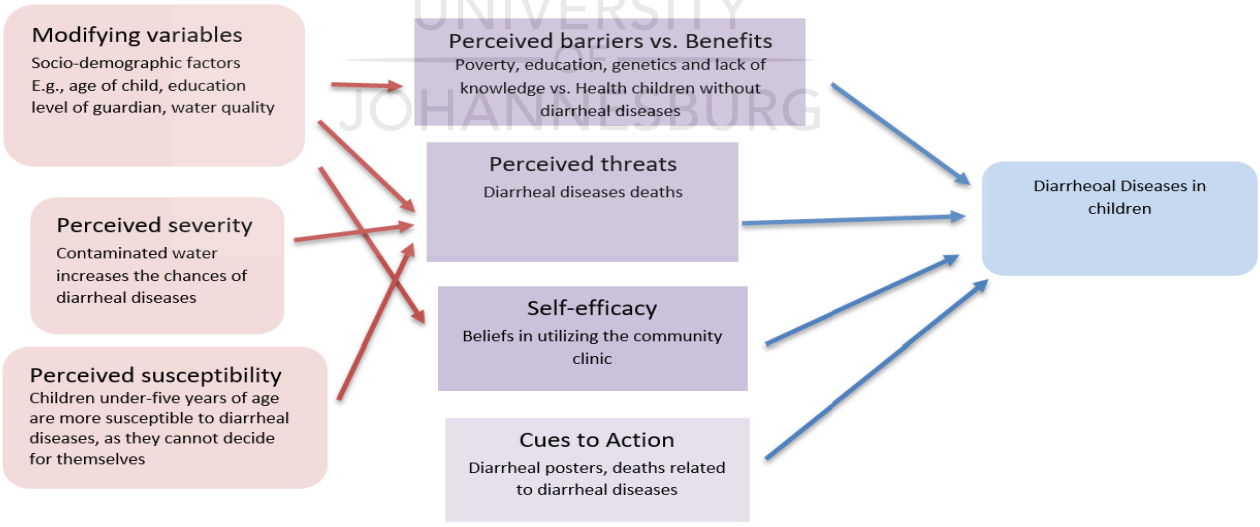


Figure 2: Shows the Health Belief Conceptual Framework for the Study *(Pennsylvania State University, 2019)*

The dependent variable in the study is children with diarrheoal diseases. The Independent variable is water quality as it measures the results of *E. Coli* in water sources utilized by study participants and the relationship with diarrheoal diseases.

According to WHO (2018) diarrheoa occurs worldwide and causes 4% of all deaths and 5% of health loss to disability. It is most commonly caused by gastrointestinal infections which kill around 2.2 million people globally yearly, mostly children in developing countries. Diarrheoa is a symptom of infection caused by a host of bacterial, viral and parasitic organisms such as *Rotavirus, Vibrio Cholera, Giardia Lamblia* most of which can be spread by contaminated water. As indicated in the perceived severity, it is more common where there is a shortage of clean water for drinking, cooking, cleaning and basic hygiene is important in prevention. Diarrheoa can also spread from person to person, aggravated by poor personal hygiene. Food is another major cause of diarrheoa when it is prepared or stored in unhygienic conditions.

Woldu, Bitew and Gizaw (2016) explained that childhood diarrheoa has resulted from interactions of socioeconomic factors. Modifying variables indicate that education status of family members, occupational status of mothers and fathers, family size, number of under-five children, household economic status, age of children and other socioeconomic factors contribute to the spread of diarrheoal disease. Socio-demographic factors have a role in the occurrence of communicable diseases through their indirect link with the quality of life, access to healthcare facilities, access to adequate water and environmental sanitation, the opportunity to use different hygienic methods, and awareness and behavior relating to disease prevention.

A parent's knowledge, perception and management skills are important to minimize the effects of morbidity and mortality associated with diarrheoal diseases as articulated in the conceptual framework's perceived barriers and benefits. In many developing countries, most diarrheoal episodes are treated at home, and mothers are the key caregivers to under-five children. They are the ones who decide about the type of food given to the child and the overall management of the disease. Therefore, their knowledge about this common disease is critically important. Awareness of and perception towards diarrheoa, and individual as well as household actions to prevent and/or manage the disease, have paramount importance to reduce diarrheoa-related morbidities and mortalities in diarrheoal diseases (Merga and Alemayehu 2015). The knowledge of caregivers and guardians of under-five children will directly influence the dependent variable in the study.

UNIVERSITY OF JOHANNESBURG

Guerrant et al, (1992) state that diarrheoa and malnutrition, alone or together, constitute major causes of morbidity and mortality among children throughout the tropical world.

2.3 Literature Search Strategy

Research questions were determined and lists of primary key words were deduced from the questions. In order to narrow down the search, there was a breakdown of the questions into key topic areas or sections, keywords (water quality, diarrheoa, Rotavirus, Dysentery etc.), phrases, and synonyms. Parentheses brackets were used to enclose search strategies to customize the results to accurately reflect the research questions as search engines deal with search statements within the parentheses first; then apply any statements that are not enclosed.

Google scholar was utilized as it has a number of health-related journals as well as Pubmed and Medline, SIGLE, Lenus, and the Cochrane Library. In addition, searches on Google were utilized and results relevant to the research questions used cited and included in the study. As the research questions were public health related, Medline search was mostly preferred. Primary research in journal articles, systematic reviews, research reports, policy documents and books, were also searched. Other primary sources used included speeches, letters, diaries, autobiographies, interviews, official reports on water quality and diarrheoal diseases. In addition, the research utilized secondary sources of data in a form of research summaries reported in textbooks, magazines and newspapers.

UNIVERSITY OF JOHANNESBURG

2.4 Literature Review

The Kingdom of Eswatini Government (2018) Master Plan towards the Elimination of Neglected Tropical Diseases Report stated that the country enjoys a sub-tropical to near-temperate climate along the western highlands, which rises to an altitude of over 1,800 meters above sea level, while the low-lying areas are generally hot. These hot temperatures promote rains, which in turn contribute to the spread of diarrheoal diseases. This research study was conducted at Madlenya community which has an estimated population of 11341 people. Administratively it is under Siphofaneni Constituency and under the leadership of a Chief assisted by an inner council. Most people earn a living through selling agricultural products including sugarcane farming. The area forms one of the catchment areas of Siphofaneni Clinic which is government owned health facility. There have been a number of interventions to improve water and sanitation at Madlenya; in 2017,

it was assisted by World Vision under Sisoma Water and Sanitation Project to construct standard VIP toilets. However, the sanitation coverage remains low due to sustainability issues and the fact that some homesteads did not complete their toilet structures. Most homesteads used water from great Usuthu River, rain- water harvesting, water from irrigation water channels, boreholes and wells. Most of the water sources used can contribute to the spread of diarrheoal diseases as they are unprotected.

Alebel et al, (2018) explain that childhood diarrheoa is defined as the passage of three or more loose or watery stools per 24 hours or an increase in stool frequency or liquidity that is considered abnormal by the mother, and the World Health Organization (2019) elaborates that diarrheoa most often results from the ingestion of pathogens from feces that have not been disposed of properly, or from the lack of hygiene. Childhood diarrheoa according to Woldu et al, (2016) has resulted from interactions of socio-demographic factors such as education status of family members, occupational status of mothers and fathers, family size, household economic status, age of children and other socioeconomic factors.

2.4.1 Rotavirus and Dysentery

Globally, Rotavirus kills approximately 527,000 young children per year, but 85 percent of these deaths occur in developing countries and Rotaviruses are the most common cause of severe diarrheoal disease in young children (WHO, 2018a). On average according to Rotavirus Organization of Technical Allies (2016), Rotavirus kills more than 330 African children under the age of five years every day and causes a significant proportion of diarrheoal diseases hospitalizations. Eswatini experienced an outbreak of Rotavirus disease in July 2014 as stated by WHO (2015) country office Biennial Report. Children who get infected may have severe watery diarrheoa, vomiting, fever, or abdominal pains. Vomiting and watery diarrheoa can last 3 to 8 days. Additional symptoms may include loss of appetite and dehydration, which can be especially dangerous for infants and young children. Khalili (2014) define Dysentery as any episode of diarrheoa in which, there is blood in loose and watery stool and that it is a major cause of childhood morbidity and mortality, especially in developing countries in Africa, Asia, and Central and Latin America. Thus, watery diarrheoa and bloody diarrheoa which are some of the symptoms of Rotavirus and Dysentery will be retrospectively studied and combined as diarrheoal diseases to determine their relationship with water quality.

UNIVERSITY OF JOHANNESBURG

2.4.2 Drinking Water and Sanitation

Clean water, basic toilets and good hygiene practices are essential for the survival and development of children (United Nations Children's Fund, 2019). Lack of access to safe, clean drinking water and basic sanitation, as well as poor hygiene cause nearly 90% of all deaths from diarrheoa globally, mainly in children. While 87% of the world's population now has access to improved water sources, 39% still lack access to improved sanitation (WHO, 2011a).

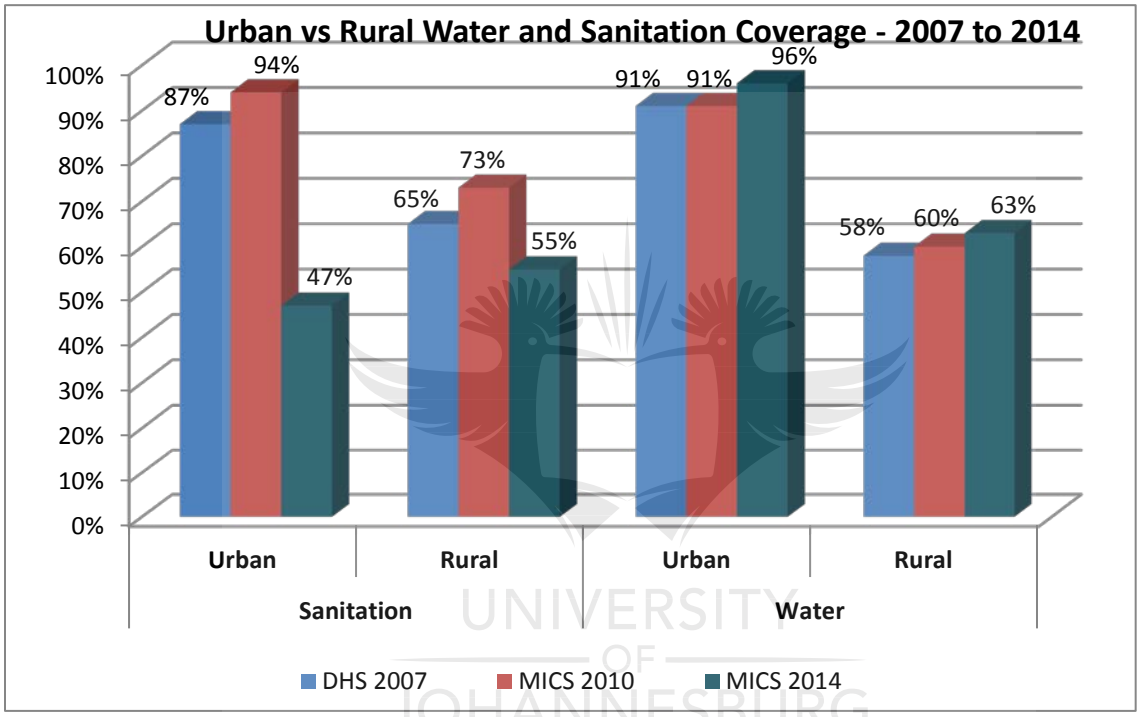


Figure 3: Shows Water and Sanitation Coverage (Multi Cluster Indicator Survey, 2014)

According to Multiple Indicator Cluster Survey (2016) in Eswatini access to safe water improved in urban areas to 96% while in rural areas it improved to 63% while access to safe sanitation in rural areas has decline from 73% in 2010 to 55% in 2014. Safe water, sanitation and hygiene are also essential to Sustainable Development Goal 3 in ensuring healthy lives and promote wellbeing for all. Lack of clean drinking water and sanitation has been known to contribute to diarrheoal diseases especially among children, thus the study will determine their relationship with water quality at household level.

UNIVERSITY OF JOHANNESBURG

2.4.3 Water Quality

The term water quality is used to describe the condition of the water, including its chemical, physical and biological characteristics, usually with respect to its suitability for a particular purpose such as drinking and cooking (Diersing, 2009) The following factors are often used to provide a measure of water quality: concentration of dissolved oxygen (DO); levels of fecal coliform bacteria from human and animal wastes; concentrations of plant nutrients nitrogen and phosphorus; amount of particulate matter suspended in the water (turbidity); and amount of salt (salinity). Stewart (2016) state that, in many bodies of water, the concentration of chlorophyll green pigment found in microscopic algae is also filtered from water samples to give a measure of the microalgae living in the water column. Quantities of pesticides, herbicides, heavy metals and other contaminants may also be measured to determine water quality.

The study concentrated on Fecal Coliform as a measure of microbial quality of water used for drinking and cooking by parents/guardians of children and WHO water quality guidelines were used as a benchmark. According to WHO (2011b) bacteriological drinking water, guidelines are widely accepted in industrialized as well as developing countries. WHO continue to state that Fecal Coliform, found in human intestines when present in certain levels, is used as an indicator of untreated or minimally treated sewage and a sign of water contamination by fecal matter. Fecal coliform bacteria are not usually harmful, but are easily detected and may indicate the presence of other disease-causing organisms carried in the human intestine such as cholera, *Shigella* and *Streptococcal diseases.*

UNIVERSITY OF JOHANNESBURG

2.4.4 Government Interventions and Challenges

The Ministry of Health in collaboration with the World Health Organization and UNICEF introduced Rotavirus vaccine in the National Immunization Program, in May 2015, with the objective of reducing the burden of Rotavirus disease in Eswatini. The vaccine was to be supplemented with good sanitary practices, vitamin A supplementation, exclusive breast-feeding and use of safe drinking water for an attainment of the goal to prevent diarrheoal diseases in children especially under-fives. There has been a rapid reduction of all-cause diarrheoa and Rotavirus hospitalizations in Eswatini, particularly in young children and during the Rotavirus season, after the introduction of Rotavirus vaccine (Maphalala, Phungwayo and Masona, 2018).

Government had continued to provide interventions for diarrheoal diseases prevention in Eswatini included vaccinations against Rotavirus, typhoid and measles; micronutrient supplementation for zinc and vitamin A, antibiotics for dysentery which has been made available in health facilities in the county; prevention and treatment of comorbidities, such as HIV; exclusive breastfeeding promotion and support; adequate nutrition for mothers and children; and interventions for the provision of water, sanitation and hygiene (WASH) in both rural and urban areas of the country. Although these health promotion interventions are affordable, there are significant challenges to increasing adoption and sustainability (Maphalala et al., 2017).

However, despite the interventions to combat diarrheoal diseases in children, the country's health system is experiencing persistent challenges such as low health-budget and a budget that is skewed towards curative rather than preventive services, depleted infrastructure and inadequate supplies to respond to the heavy burden of disease. Health management systems, including financial management and budgeting, are centralized and mostly unresponsive to the new health development challenges at different levels of service delivery (Eswatini Ministry of Health, 2018).

The increase in-patient loads, long queues, shortened consultation times by health care providers combined with the complexity of many cases associated with HIV and AIDS, have all militated against the quality of health care. The national capacity to effectively manage information, research and knowledge requires strengthening. The National Health Sector strategic plan states that national health information is not easily accessible to potential users due to uncoordinated health information systems (Government of Eswatini, 2015). This leads to health information about the country being either outdated and/or unavailable in national, regional and international databases. Lastly, the Ministry faced difficulties filling vacant positions in remote areas because of staff reluctance to accept posting to those areas due to various reasons such as, accommodation, good schools for children etc. All these factors have contributed immensely to the continued spread of diarrheoal diseases in children in Eswatini directly or indirectly.

UNIVERSITY OF JOHANNESBURG

2.4.5 Similar Studies

Despite the global decline in death rates of children younger than five years old, the risk of a child dying before turning five years of age remains highest in the World Health Organization African Region (Anteneh et al., 2017). A study carried out in Kenya showed that six factors were independently associated with diarrheoal diseases, these are occupation of the parent/guardian,

care taker not washing hands after changing napkins, child drinking untreated water from the river, child not exclusively breastfed, child not washing hands before eating and after visiting toilet (Getachew et al., 2018). Water treatment at the point of water usage has been advocated as means to substantially decrease the global burden of diarrheoa and to contribute to the Sustainable Development Goals number 6; however, there is not enough evidence on the acceptability and non-health benefits of the methods (Kakulu, 2012). Improving our understanding of the relationship between water quality and diarrheoal diseases according to Levy (2015) will require more understanding of both exposure and responsible variables. Innovations to improve specificity in exploring water-diarrheoa relationships may include direct testing for pathogens, high volume sampling, more objective health endpoints, indicators that are more specific to humans and correlated with pathogens, and innovative study designs.

Assessment in studies on the relation between water quality and diarrheoal diseases is difficult. People can change drinking water sources in the course of a study and even if they stick to one source, the bacteriological water quality in this source can change over time. Many epidemiological studies have been based on a low water quality sampling frequency, which may be sufficient to capture seasonal variation, but not short-term changes in quality or in choice of drinking water sources (Jensen, 2004).

In Eswatini, Between January 2013 and December 2014, 331 children below the age of five years were hospitalized for management of acute gastroenteritis in the two sentinel site hospitals. All cases had stool samples collected, of which 302 were tested for Rotavirus (Maphalala et al., 2017). According to Kingdom of Eswatini Government (2016) in 2014, the Central Statistical Office (CSO) conducted the fifth round of the Multiple Indicator Cluster Survey (MICS), an international household survey developed by UNICEF to monitor progress towards the goals and targets of the Plan of Action for the World Fit for Children (WFFC) Declaration and the Millennium Declaration. The 2014 Eswatini MICS was designed to provide estimates for indicators on the situation of the country at the national level, for urban and rural areas, and for the four administrative regions of Eswatini: Hhohho, Manzini, Shiselweni and Lubombo. The overall two weeks' period-prevalence of diarrheoa in children under-five years of age was 16 percent and the period-prevalence for diarrheoa ranged from 13 percent in Hhohho region to 20 percent in Shiselweni region.

UNIVERSITY OF JOHANNESBURG

2.5 Conclusion

Literature review is the current state of knowledge on the research topic as established in academic books and journal articles. In order to gather current information on the topic a literature search strategy was developed, specifying the type of literature, identifying sources, and setting the scope of the literature to search. For literature review, primary and secondary data sources were utilized. Internet searches such as Google scholar, PubMed, aided by Boolean operators were used to combine searches and specificity. The literature review included information such as the location of the research study, the sample population dynamics and socio-demographic factors that might contribute to diarrheoal diseases in children under-five years at Madlenya. Currently information on the status of diarrheoal diseases in the world, country, community and household level was researched and linked to the research topic. Information on both variables that is independent and dependent variable was researched and collated into the research study. Other studies on diarrheoal diseases in under-five children were also compared to the research topic to decide the scope of literature review and provide information on what other studies had concluded.

UNIVERSITY
OF
JOHANNESBURG

CHAPTER 3: STUDY DESIGN AND METHODOLOGY

3.1 Study Design

A Cross-Sectional Analytical study was conducted at Madlenya community to determine the relationship between water quality and diarrheoal diseases in children under-five years of age. According to Setia (2016), Cross-Sectional Analytical study is a type of observational study that analyzes the outcomes and exposures in the study participants at a particular time. The Cross-Sectional Analytical study was ideal because it is cheaper to conduct because there is no follow-up required. It was indeed affordable for the researcher as this was a self-funded with limited resources. Cross-sectional studies as Gaile, (2018) explains, allow multiple variables to be accessed simultaneously, which increases the accuracy of the research on the burdens of a data point within the specific population group.

3.2 Study Area

Figure 4: Study Area Map satellite view Google Earth Pro 7

The study was conducted at Madlenya community which is located in the Lubombo Region of Eswatini about 15 Km from Siphofaneni Town with a geographical location of 21°41′S 31°39′E. The area is located in the Lowveld which is the low-lying part of Eswatini and its altitude according to Climate Travel (2018) ranges from 200m to 400m on average, and a generally hot region with annual temperatures of 22 degrees Celsius which records an average rainfall of 500 to 900 mm per

annum. Most people at Madlenya earn a living through sugar cane farming and operating small income generation projects at Siphofaneni Town.

An increase in diarrheoal diseases has been noted with concern over the past years at Madlenya community, thus the area provided an ideal study site, especially in determining the prevalence of diarrheoal diseases in children under-five years. In addition, the study area was selected because it is part of the employment catchment areas for the researcher. Madlenya also has a number of water sources used for drinking water which enabled comparison for the relationship between water quality and diarrheoal diseases. Madlenya's climatic conditions are ideal for the spread of diarrheoal diseases thus the study will be helpful for the people of Madlenya in determining factors contributing to the spread of diarrheoal diseases.

3.3 Study Population

The study populations were parents or guardians of children under-five years of age having diarrheoal diseases at Madlenya during the study period, including the day of the survey. All households with children under-five years were identified and children to be included in the study were sampled using random sampling technique. Parent/guardian were then interviewed using a predesigned and pretested questionnaire used to collect data on age group of children, sex of child, employment status and level of education of parent/guardian, water and sanitation status, hygiene practices and general knowledge of diarrheoal diseases. Parents/ guardians of children who had diarrheoal diseases during the study period were requested to produce child's immunization card to determine symptoms associated with Rotavirus or Dysentery.

UNIVERSITY OF JOHANNESBURG

3.4 Sampling Strategy

The sampling strategy for the study was probability sampling using simple-random sampling technique. Simple random sampling method was ideal for the study as it is inexpensive and easy to conduct. A list of all children under-five years of age was obtained from Madlenya Royal Kraal and from Rural Health Motivators records. In random sampling, each household with children under-five years of age had an equal probability of being chosen (Hayes, 2019). Households with children under-five years of age were identified. The children's names were written in a piece of paper and placed inside a card box. The researcher then blindly selected one piece of paper randomly and noted down the name of the child to include in the study. Inclusion into the study

was determined by calculating sample size using EPINFO 7.2. Once selected, the paper was then set aside and the process repeated until the sample size for the study was obtained. These identifying papers were destroyed to keep participants anonymous in the dataset.

3.5 Sample Size Estimation

Sample size according to Sciencing (2019) measures the number of individual samples measured or observations used in a survey or experiment**.** The sample size for the study was calculated using EPINFO version 7.2, which is a statistical software for epidemiology developed by Centers for Disease Control and Prevention. The sample size was calculated for a Cross-Sectional study using population survey approach. EPINFO 7.2 was chosen as it has a tool which can be used to calculate sample size for research studies.

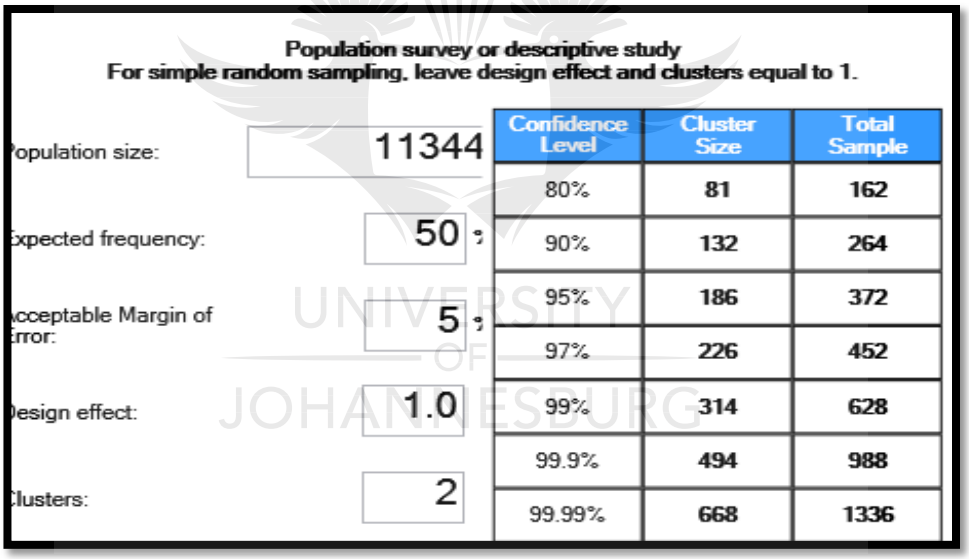


Figure 5: Sample size estimation Using EPINFO 7.2

The estimated sample size for the study calculated using EPINFO 7.2 was 372 children. The sample size was calculated using an acceptable error margin of 5% and 2 clusters at 95% confidence level. A 5% contingency was added for multiple comparison (372+19) giving a total sample size of 391. Therefore, the sample size of 391 children under-five years of age was considered a representation of the entire population of under-five-children at Madlenya.

3.6 Inclusion Criteria

3.6.1 Parents/Guardians of Children: Parents/guardians of children were interviewed in the study. The study intended to generate data on the relationship between water quality and diarrheoal diseases in children under-five years. Included in the study are all parents or guardians of children under-five years of age. The reason to include parents or guardians of children under-five years of age was to interview them to obtain data on children under-five years of age who cannot answer questions for themselves. In addition, children with health cards and diagnosed with diarrheoal diseases within the study period were included in the study.

3.6.2 Childs History with symptoms associated with Rotavirus and Dysentery: Parents/guardian who had children with diarrheoal diseases during the study period were required to provide children's immunization cards to determine clinical diagnosis with symptoms associated with Rotavirus or Dysentery such as watery diarrheoa and bloody diarrheoa.

3.7 Exclusion in the Research Study

Excluded from the study were children above five-years of age and parents or guardians of children who have not be residing with under-five children for at least 6 months. The reason to exclude them was because they did not fall within the study period which was 6 months thus may have no complete information about the child clinical history. In addition, children who did not have health cards and whose diagnosis were not ascertained we excluded from the study.

UNIVERSITY OF JOHANNESBURG

3.8 Type of Data

The study collected quantitative data to determine the relationship between water quality and diarrheoal diseases in children under-five years at Madlenya community. Quantitative data was collected to determine the prevalence of diarrheoal diseases at Madlenya and the number of water sources with contaminated water and other numerical data.

3.8.1 Primary sources of data

Primary sources of data included a population survey which administered a pretested and predefined questionnaire on the sampled population. The questionnaire was administered using

one on one interviews with parents or guardians of children under-five years of age sampled for the study. The questionnaire was validated through pretesting in an adjacent Phumlamcashi community. The questionnaire obtained data on a number of variables identified in the study such as socio-demographic factors, water and sanitation factors, knowledge on diarrheoal diseases, and prevalence of diarrheoal diseases in children under-five years of age.

Biomarkers were used to collect primary source of data in determining demographic data, sanitation practices and diarrheoal data of children under-five years sampled in the study. Another source of primary data were water samples collected on sources of water used for drinking by sampled population to determine the presence of fecal coliform that could contribute to diarrheoal diseases in children under-five years of age. Water samples were collected from identified water sources after interviews with parents/guardians of children. Data on water quality variable was obtained using laboratory results on water samples.

3.8.2 Secondary Sources of Data

Data was collected on the total number of households in the study area from records captured by Rural Health Motivators. In addition, secondary data collected by the Rural Health Motivators on the total number of children under-five five years of age in the study was included. This data helped to derive demographic data variables such as age, sex and physical location of children under-five years of age. Parents/guardians of children who had diarrheoal disease during the study period were requested to produce child immunization cards in order to determine symptoms of diagnosed diarrheoa.

UNIVERSITY OF JOHANNESBURG

Table 1: Dependent and Independent Variables

Variable Name	Variable of type	Description	Variable Source	Level of measurement	How it is Measured
Social Demographics					
Age Group of Children	Independent	Age of children included in the study in months.	Questionnaire Data File	Continuous and later Categorical	Less than 12 Months-1
					12-24 Months - 2
					25-36 months - 3
					37-48 Months- 4
					49-60 Months -5
Gender of Children	Independent	Gender of children include in the	Questionnaire Data File	Categorical	Male - 1
					Female - 2

Age of parent	Independent	Age group of parents	Questionnaire Data File	Categorical	Less than 20 years - 1
					20 - 30 years - 2
					31 - 40 years - 3
					41 - 50 years - 4
					51 - 60 years - 5
					61+ - 6
Level of education of parent	Independent	Level of education of parents of children	Questionnaire Data File	Categorical	Never attended - 1
					Preschool - 2
					Primary school – 3
					Secondary school – 4
					High school – 5
					Tertiary education - 6
					Elderly education – 7
					Don't know - 8
Employment status	Independent	Employment status of parents	Questionnaire Data File	Categorical	Yes -1
					No – 2
					Self-employed - 3
Water and Sanitation Factors					
Water Source	Independent	Water sources used by participants for drinking water	Questionnaire Data File	Categorical	Borehole water – 1
					Protected spring - 2
					Rainwater - 3
					Unprotected dug well - 4
					River water - 5
Fecal coliform count results	Dependent	Fecal Coliform Results of water sampled from water sources	Questionnaire Data File	Continuous	0 CFU's/100ml
					11.29 CFU's/100ml
					70.31 CFU's /100ml
					1265.78 CFU's/100ml
					1502.02 CFU's /100ml
Water Treatment	Dependent	Do parents/guardians treat water before drinking	Questionnaire Data File	Categorical	Yes - 1
					No - 2
Water treatment Actions	Dependent	How do parents/guardians treat water	Questionnaire Data File	Categorical	Boil water- 1
					Use jik/water Guard - 2
					Use ash - 3

UNIVERSITY OF JOHANNESBURG

Sanitary Facility	Dependent	Type of toilet used by parents/guardians of the study	Questionnaire Data File	Categorical	Water flush toilet - 1
					VIP toilet- 2
					Open pit latrine or traditional pit latrine - 3
					Bushes or forest - 4
Hygiene Practices					
Hand Washing	Dependent	Do Parents wash hands and when?	Questionnaire Data File	Categorical	After using the toilet - 1
					Before preparing food - 2
					Before eating - 3
					After cleaning child feces - 4
					After handling animals - 5
					Does not wash hands - 6
Hand Washing Equipment	Dependent	What parents use to wash their hands	Questionnaire Data File	Categorical	Running water and soap - 1
					Water in a basin and soap- 2
					Water in a basin and ash - 3
					Running water only - 4
					Water in a basin only - 5
					Don't wash hands - 6
Knowledge of Diarrheoal Diseases					
Types of Diarrheoa	Dependent	Knowledge of the different types of diarrheoa	Questionnaire Data File	Categorical	Yes - 1
					No - 2
Difference between Rotavirus and Dysentery	Dependent	Knowledge of the difference between Rotavirus and Diarrhea	Questionnaire Data File	Categorical	Yes - 1
					No - 2
Children with Diarrheoal diseases	Dependent	Number of children with diarrheoal diseases	Questionnaire Data File	Categorical	Yes - 1
					No -2
Diarrheoal Diseases prevention		Knowledge of how to prevent Diarrheoal Diseases	Questionnaire Data File	Categorical	Do not know - 1
					Latrine usage - 2
					Covering food - 3

UNIVERSITY OF JOHANNESBURG

					Drinking clean water- 4
					Treating water - 5
					Store water safely - 6
					Prepare food properly - 7
					Wash hands with Water and soap - 8
					Going to traditional healer 9
Child had acute watery or Bloody diarrheoa	Dependent	Has child had bloody or Watery Diarrheoa	Questionnaire Data File	Categorical	Watery Diarrheoa - 1
					Bloody Diarrheoa - 2

3.9 Data Collection Concepts and Techniques

A paper-based questionnaire was used to collect data and face-to-face interviews were conducted on parents/guardians of children sampled for the study. Moreover, children immunization cards were observed to determine diagnosed symptoms of diarrheoa in children specifically for symptoms associated with Rotavirus (acute watery diarrheoa) and Dysentery (bloody diarrheoa). Interviews were conducted in all households with sampled children and conducted by 10 Rural Health Motivators selected and trained on the use of the questionnaire. The RHMs also helped to translate the questionnaire to Siswati language which is our local language.

UNIVERSITY OF JOHANNESBURG

In addition, drinking water samples from water sources and households sampled were collected for laboratory micro-bacterial analysis, mainly for *Escherichia Coli* which is known to cause diarrheoal diseases. In total 13 water samples were taken using sterilized 500 ml polyethylene bottles obtained from the Swaziland Water Services Corporation (EWSC). The Grap Sampling technique was used to collect water from the Usuthu river at three points of water collection at a depth of approximately 30 centimeters from the water surface. All collected water samples were transported to the EWSC laboratory in a cooler box with ice cubes on the same day to preserve quality. The samples were tested for physical, chemical, and microbiological quality. According to EWSC the analysis of fecal coliform was performed using deionized distilled water with the growth medium being 50 g m-FC broth and 100 ml water. The broth was boiled. During the boiling

of the broth, constant stirring was done to avoid burning of the undissolved media. The broth was poured into a 47 mm filter culture plates. Upon testing using the membrane filtration procedure, all green colonies were counted and the results presented as fecal coliforms per 100 ml.

3.10 Pilot Study

The main aim of conducting the pilot study was to improve the quality and efficiency of the data collection instrument. The questionnaire was divided into four sections that covered different aspects of interest in the study. Five parents/guardians of children under-five years of age were selected at different households at Phumlamcashi community and five health workers were selected at Siphofaneni Clinic to be part of the pilot study. Phumlamcashi community is located about 3 km from the proposed study area and shares the same attributes with the study area such as cultural norms, sanitation profile and traditional leadership style.

Each parent/guardian was interviewed using the questionnaire form and a number of observations were made with regards to appropriateness of questions, completion rate, correctness of questionnaire, the effectiveness of the questions in fulfilling the purpose of the study, response rate, data quality, and the comprehensiveness of the questionnaire. The interviews were conducted at the parent/guardians household and Siphofaneni Clinic, in Siswati language for them to fully understand the questions. For comparison, the questionnaire was pretested for two consecutive days to the same parents/guardians.

UNIVERSITY OF JOHANNESBURG

The completion rate for the questionnaire was 100%, meaning all the questionnaires that were used for the pilot study were successfully completed. The average time taken to complete the questionnaire was 20 minutes with the maximum time being 35 minutes and the minimum time being 15 minutes. Due to the high completion rate of the questionnaire, it was deduced that it was comprehensive. This can be attributed to the fact that it was arranged in sections with similar questions grouped together for easy flow. Overall, the questionnaire pilot study was successful and it reflected that the data collection instrument was capable of collecting the desired data for the study.

3.11 Reliability

Reliability is the extent to which results can be reproduced when the research is repeated under the same conditions (Middleton, 2019). In order to assess reliability aspects of the data collection instrument, the consistency of results we checked across time, across a different group of participants and across parts of the questionnaire. The questionnaire was administered in parents/guardians of children under-five years of age at Phumlamcashi, and it was administered to five health care workers at Siphofaneni Clinic.

At Phumlamcashi, the questionnaire was administered on two consecutive days on the same group of participants. The reliability of the data collection instrument across the two days it was administered showed that it was reliable as the same results were obtained. However, it was noted that on the second day the completion rate for the questionnaire had improved, as participants were now familiar with questions. The result obtained by administering the questionnaire on two different group of participants showed that the questionnaire was reliable as the results were similar. The parent/guardian's responses were similar to the responses obtained from interviews with health workers at Siphofaneni Clinic. This demonstrated that the questionnaire was comprehensive, as it was easy understood by both group of participants as well as able to capture the required data. The data collection instrument layout design ensured reliability as it was arranged in sections for easy flow. The smooth flow is essentially for participant's comprehensiveness of the questionnaire.

UNIVERSITY OF JOHANNESBURG

3.12 Validity

Validity refers to how accurately a method measures what it is intended to measure in the research study (Middleton, 2019). Validity was ensured by the extent to which the aspects of the research questions are covered in the questionnaire. The questionnaire was proofread for error, grammar mistakes and relevance to the research topic and capabilities in answering the research questions and alignment to research objectives. During the pilot, study the questionnaire demonstrated capabilities of collecting necessary data to answer research questions. In addition, all sections in the questionnaire were answered ensuring coverage of all objectives of the research study. Further to ensure validity the pilot study participants were chosen to represent the study population as much as possible as the community is adjacent to the study area thus sharing similar characteristics

and living conditions. Lastly, the questionnaire was valid as the result obtained corresponds to other similar studies of the same concept.

As a conclusion, validity was harder to assess than reliability, but it is even more important. Necessary adjustments and corrections we made to ensure that the data collection instrument measures what it is intended to measure thus improving the quality of the research study.

3.13 Data analysis

Data analysis was conducted for all children diagnosed with diarrheoal diseases during the study period. Data analyzed included age group of children, education level of parents, employment status, water and sanitation factors and knowledge of diarrheoal diseases by parents or guardians of children.

SPSS statistical software was used to enter data, after which data was cleaned before analysis. Data cleaning involved checking each variable for impossible or unusual values. Inadmissible values were detected by comparing values with results and the software aided in the detection of other errors in the variables. Data was then summarized in a concise form for descriptive analysis, e.g. contingency tables that classify the observations according to key factors. Summarized data was used to estimate the epidemiologic measures of interest, such a mean, media, mode, standard deviation and prevalence of diarrheoal diseases in the study population. SPSS statistical software was utilized to compute descriptive statistics on the variables such as age, gender of children, education level of guardians, and knowledge of diarrheoal diseases. After which data was interpreted which required consideration of unmeasured factors that may have influenced subject selection, measurement and risk, (bias, misclassification and confounding), as well as issues of statistical inference.

UNIVERSITY OF JOHANNESBURG

3.13.1 Data Analysis by Objective

Objective 1: Data to examine the relationship between children with diarrheoal diseases and water quality was inputted into a statistical software SPSS for analysis. Frequency distributions and cross tabulations of children with and without diarrheoa were conducted after which logistic regression was used to compare the Adjusted Odds Ratios of diarrheoal disease by adjusting for age group of children, gender, and education level and employment status of parents/guardians.

Objective 2: The relationship between diarrheoal diseases and drinking water quality was determined by sampling water for laboratory analysis from water sources utilized by study participants. Water sample results were used to determine whether water sources were contaminated with *E. Coli*. The water samples were collected and stored in a cooler box with ice to avoid decomposition. The fecal coliform analysis was conducted using deionized distilled water with the growth medium being 50 g m-FC broth and 100 ml water.

Objective 3: Practices that impact water quality negatively at household level were coded for easy analysis using statistical software SPSS. Once coded data was entered into software and data analyzed for frequencies and graphs generated. Furthermore, crude and adjusted odds ratios were conducted using EPINFO 7.2 and binary logistic conducted in SPSS to determine the relationship between diarrheoal diseases and hygiene practices.

3.14 Ethical Consideration

The Study was conducted with the highest standard of ethical considerations. Ethics approval was applied from the University of Johannesburg and it was granted (see appendix 2). Permission from Madlenya Royal Kraal was applied prior to conducting the research and it was granted (see appendix 3).

UNIVERSITY OF JOHANNESBURG

3.14.1 Informed Consent: All participants in the study we informed about the objective of the research study. After which permission was requested from parents and guardians of children under-five years of age to participate in the research by signing a consent form (see appendix 5). The consent was obtained before interviews and preceded by an explanation of the study and its purposes. Participants who were not willing to participate were not coerced or forced. No identifying information was collected from the participants. Lastly, parents/guardians who did not want to produce their children's immunization cards were interviewed and requested to recall if children have had diarrheoal diseases during the study period (6months).

3.14.2 Beneficence: Participants of the study were treated with dignity and respect and the benefits of the study were clearly explained to them. This includes reduction in the prevalence of diarrheoal diseases and knowing the status of their water sources in terms of contamination.

3.14.3 Justice: The study strived to promote social good and prevent social harm through respect for participants. It also avoided discrimination of participants in the basis of sex, race, ethnicity or other factors not related to scientific competence and integrity.

3.14.4 Autonomy: Participants were assured of anonymity. The study questionnaires used unique identifiers to ensure that data that cannot be used to trace to an individual participant.

3.14.5 Privacy and Confidentiality: Participants names in the study were coded, thus their names will not appear in the final research document. In addition, carefulness in data handling has been exercised to prevent data loss and leaking thus exposing study participants. In addition, the study promoted social-good and prevented social harm through respect for participants. Privacy was ensured during interviews by ensuring that parents were interviewed where they could not be overheard, as agreed by them. Data collected is kept safe where no one will have access other than the Researcher. Training of research assistants also emphasized the importance of privacy and confidentiality. Finally, reporting ensures that findings cannot be linked to individuals without their prior consent.

3.15 Limitations of the Study

UNIVERSITY OF JOHANNESBURG

The first limitation of the study is that it was written in English which is a second language in Eswatini. This means that the questionnaire administered by Rural Health Motivators had to be translated to our local language, risking the introduction of translation bias.

Another limitation of the study is that it relied on child's immunization cards to determine symptoms associated with Rotavirus and Dysentery within the study period, without confirmation from physicians or doctors, with the potential of causing calculation of biased prevalence of both diarrheoal diseases. Moreover, the use of symptoms to determine the presence of Rotavirus and Dysentery in children could cause inaccurate results of the presence of the diseases at Madlenya. Parents or guardians of children were required to remember the health status of children within the study period (6 months) which had a potential of introducing recall bias. However, this was minimized by including questions that were used to triangulate the information provided.

Exposure assessment in studies on the relation between water quality and diarrheoa was difficult because parents/guardians of children changed drinking water sources in the course of the study and even if they stick to one source, the bacteriological water quality in this source can change over time. These limitations provide opportunities for future follow-up research on diarrheoal diseases in children.

3.16 Strengths of the Study

The study seeks to provide new insight into the extent of diarrheoa among children under-five in at Madlenya. The findings of the study will be helpful in designing appropriate interventions in preventing childhood diarrheoa at Madlenya, Lubombo Region and the country as a whole. Previously, there have been limited studies conducted on diarrheoal diseases in children in the country, thus the study provided a baseline for future studies on diarrheoal diseases. The study population was manageable thus the study provides results that are more accurate thus reliable.

3.17 Public Health Implications of the Study

The study seeks to provide useful information on diarrheoal diseases in children to the Ministry of health and Non-Governmental Organizations. The research findings will help fill existing information gaps on diarrheoal diseases thus improving public health in the country as informed policies on diarrheoal diseases will be formulated. Improvements in public health policies will eventually help reduce mortality associated with diarrheoal diseases in children as well as adults. The study participant's water sources will be sampled for laboratory analysis; thus awareness will be raised on sources that are potentially contaminated. Parents or guardians of children will be made aware of the diarrheoal diseases as well as preventive methods thus greatly improving public health at community level. Socio-demographic factors that could contribute to diarrheoal diseases in children will be explored as public health has a number of determinants that affects one's chance of getting diseases.

3.18 Possible Outcomes

As data is collected at Madlenya community, awareness on the importance of water quality and the relationship with diarrheoal diseases in children will be raised. The community will have their water sources sampled and taken for analyses thus they will be aware of the quality of water they

UNIVERSITY OF JOHANNESBURG

are using prompting measure to improve water quality and explore locally available water treatment options. Study results will also provide a basis for seeking assistance from non-profit making organizations, government and partners to combat diarrheoal diseases and improve water quality if not according to acceptable standards. Also, individuals especially mothers or caregivers will be aware of the water treatment options that can be used to ensure water is safe to be utilized by children, as well as distinguish the different types of diarrheoa in children.

UNIVERSITY
OF
JOHANNESBURG

CHAPTER 4: RESULTS AND INTERPRETATIONS

4.1 Introduction

In this chapter, the results of the study are interpreted and presented mainly in a form of tables and graphs. The results are interpreted and presented in relation to the research questions which guided the study thus arranged according to the sections of the questionnaire, namely demographic factors of participants, water and sanitation factors, hygiene practices factors, and knowledge of diarrheoal diseases of parents/guardians of children. In total, 391 parents or guardians of children under-five years of age were successfully interviewed using the predesigned questionnaire. Data from the questionnaire was inputted into Statistical Package for the Social Science (SPSS) version 25 to determine its correctness, completeness and accuracy. The demographic data for children and parents or guardians included in the study was as follows.

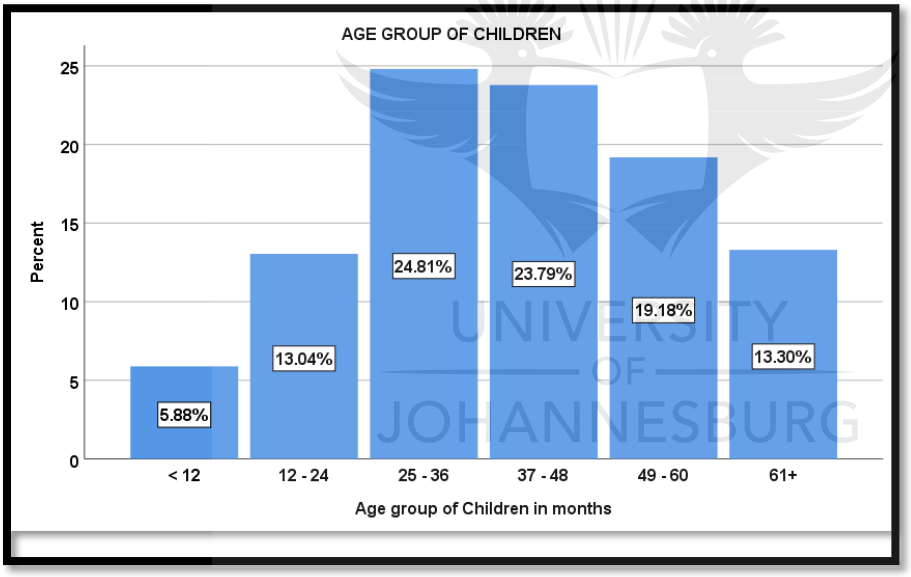


Figure 6: Shows the age group distribution of children

The age group of all under-five years' children sampled for the study was grouped into 6 categories. The most dominant age-group were children from 25-36 months with 24.81% (97) and the age group with the least number of participants was children less than 12 months with 5.86% (23).

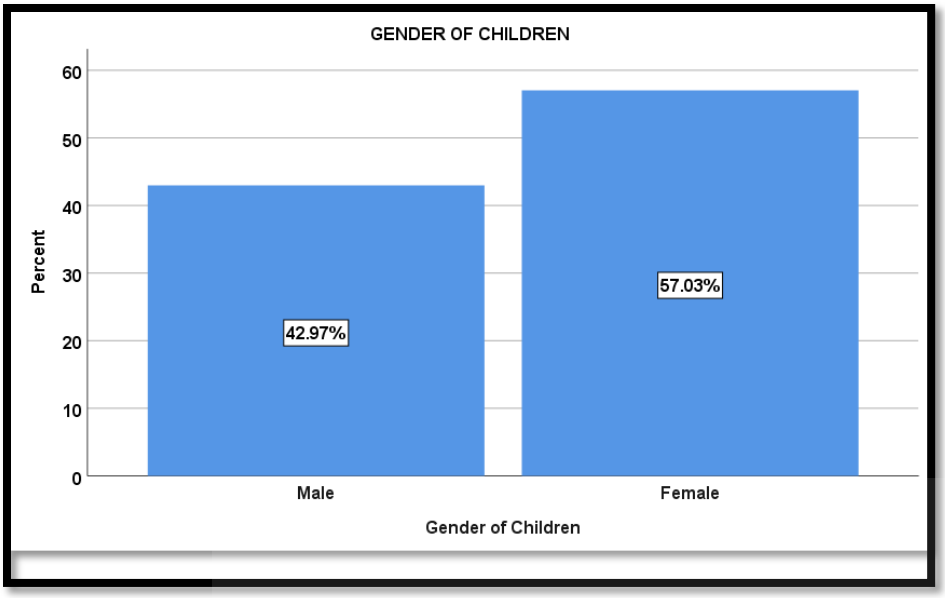


Figure 7: Shows the gender of children sampled for the study

The study findings indicated that, females constituted 57.03% of the study participants and the majority of the participants were in the 25 – 36 months (24%).

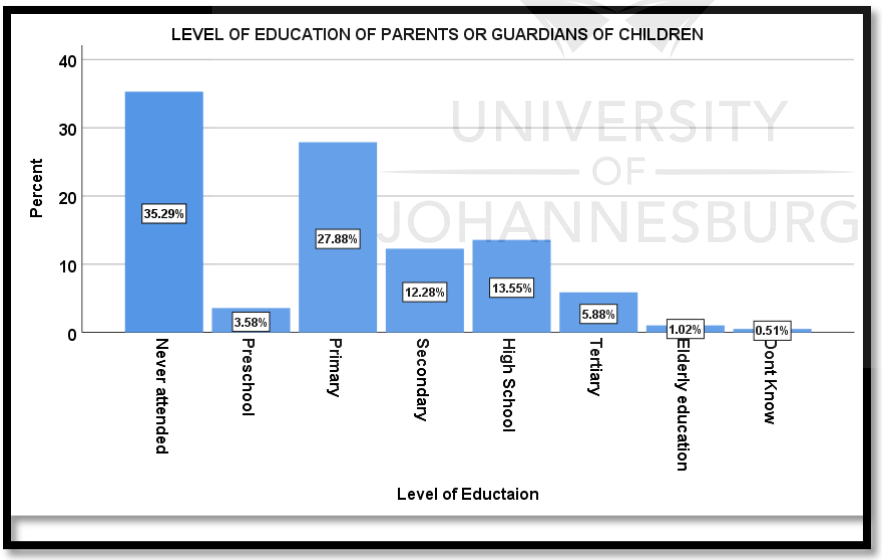


Figure 8: Shows the level of education of parents or guardian of children

This variable assessed the level of education of parents/guardians of children under-five years of age. The findings indicate that, most of the parents/guardians 138 (35.29%) never attended school, followed by 109 (27.88%) whose highest level of education was primary school.

4.1.1 Research Questions

1) What is the relationship between diarrheoal diseases and children under-fives years of age at Madlenya community?
2) What is the relationship between diarrheoal diseases in children under-fives years and drinking contaminated water in Madlenya?
3) What practices impact water quality negatively and the relationship between water quality and diarrheoal diseases at Madlenya.

Table 2: Frequency Distribution of Participants and Parents/guardian by Diarrheoal Diseases

Characteristics	**Responses**	**TOTAL**		**Children with Diarrheoa**		**Children without Diarrheoa**	
		n	**%**	***n***	**%**	***n***	**%**
Age Group of Children	Less than 12 Months	23	5.9%	18	8.0%	5	3%
	12 - 24 Months	51	13.0%	32	14.3%	19	11.4%
	25 - 36 months	97	24.8%	53	23.7%	44	26.3%
	37 - 48 Months	93	23.8%	49	21.9%	44	26.3%
	49 - 60 Months	75	19.2%	47	21%	28	16.8%
Gender of children							
	Male	168	43%	92	41.1%	76	45.5%
	Female	223	57%	132	58.9%	91	54.5%
Age of parent or guardian							
	Less than 20 years	38	9.7%	20	8.9%	18	10.8%
	20 - 30 years	86	22%	55	24.6%	31	18.6%
	31 - 40 years	107	27.4%	63	28.1%	44	26.3%
	41 - 50 years	81	20.7%	43	19.2%	38	22.8%
	51 - 60 years	52	13.3%	28	12.5%	24	14.4%
	61+	27	6.9%	15	6.7%	12	7.2%
Level of education of parent or guardian							
	Never attended	138	35.3%	108	48.2%	30	18%
	Preschool	14	3.6%	10	4.5%	4	2.4%
	Primary school	109	27.9%	55	24.6%	54	32.3%
	Secondary school	48	12.3%	23	10.3%	25	15%
	High school	53	13.6%	16	7.1%	37	22.2%
	Tertiary education	23	5.9%	8	3.6%	15	9%
	Elderly education	4	1%	3	1.3%	1	0.6%

UNIVERSITY OF JOHANNESBURG

	Don't know	2	0.5%	1	0.4%	1	0.6%
Employment status							
	Yes	82	21%	46	20.5%	36	21.6%
	No	230	58.8%	132	58.9%	98	58.7%
	Self employed	79	20.2%	46	20.5%	33	19.8%

4.2 Frequency Distribution of Demographic Factors

The main aim of this section was to obtain demographic data of study participants and 97 (24.8%) of the children included in the study were of the age group 25 – 36 months and 23 (5.9%) were children less than 12 months. The findings indicate that, there were 53 (23.7%) children with diarrheoa in the age group 25 – 36 months and 8% (18) children with diarrheoal diseases in the age group less than 12 months.

Female children with diarrheoal diseases were 132 (58.9%) while male children were 92 (41.1%) and in total, there were 223 (57% female children included in the study while males were only 168 (47%). The age group 31 – 40 years formed the majority group of parents with 107 (27.4%) while those above 61 years were only 27 (6.9 %). Children with diarrheoal diseases in the age group of parent 31- 40 years were 63 (28.1%) with only 15 (6.7%) in the age group above 61 years of age.

Parents or guardians who never attended school were 138 (35.3%) followed by those who attended primary school 109 (27.9%). Parents or guardians who never attended school had 108 (48.2%) children with diarrheoal diseases. Lastly, unemployed parents or guardians had 132 (58.9%) children with diarrheoal diseases while employed parents had 46 (25.5%) children with diarrheoal diseases.

Table 3: Frequency Distribution of Participants and Parents/guardians by Symptoms associated with Rotavirus and Dysentery.

Characteristics	**Responses**	**TOTAL**		**Rotavirus (Watery Diarrheoa)**		**Dysentery (Bloody Diarrheoa)**	
		n	**%**	***n***	**%**	***n***	**%**
Age Group of Children	Less than 12 Months	18	8 %	7	6.6%	11	9.3%
	12 - 24 Months	32	14.3%	18	17%	14	11.9%
	25 - 36 months	53	23.7%	27	25.5%	26	22%
	37 - 48 Months	49	21.9%	21	19.8%	28	23.7%
	49 - 60 Months	47	21%	23	21.7%	24	20.3%

Gender of children							
	Male	92	41.1%	44	41.5%	48	40.7%
	Female	132	58.9%	62	58.5%	70	59.3%
Age of parent or guardian							
	Less than 20 years	20	8.9%	6	5.7%	14	11.9%
	20 - 30 years	55	24.6%	31	29.2%	24	20.3%
	31 - 40 years	63	28.1%	30	28.3%	33	28%
	41 - 50 years	43	19.2%	18	17%	25	21.2%
	51 - 60 years	28	12.5%	14	13.2%	14	11.9%
	61+	15	6.7%	7	6.6%	8	6.8%
Level of education of parent or guardian							
	Never attended	108	48.2%	52	49.1%	56	47.7%
	Preschool	10	4.5%	8	7.5%	2	1.7%
	Primary school	55	24.6%	23	21.7%	32	27.1%
	Secondary school	23	10.3%	11	10.4%	12	10.2%
	High school	16	7.1%	6	5.7%	10	8.5%
	Tertiary education	8	3.6%	4	3.8%	4	3.4%
	Elderly education	3	1.3%	1	0.9%	2	1.7%
	Don't know	1	0.4%	1	0.9%	0	0%
Employment status							
	Yes	46	20.5%	27	25.5%	19	16.1%
	No	132	58.9%	57	53.8%	75	63.6%
	Self employed	46	20.5%	22	20.8%	24	20.3%

UNIVERSITY OF JOHANNESBURG

4.3 Frequency Distribution of Participants and Parents/guardians by Symptoms associated with Rotavirus and Dysentery.

The results indicated that there were 27 (25.5%) children diagnosed with symptoms associated with Rotavirus in the age group 25 – 36 months and 28 (23.7%) children with symptoms associated with Dysentery in the age group 37 – 48 months. There were also 92 (41.1 %) male children and 132 (58.9 %) female children with diarrheoal diseases with 44 (41.5%) males with symptoms associated with Rotavirus and 48 (40.7%) males with Dysentery. Parents/Guardians who never attended school had 52 (49.1 %) children diagnosed with symptoms associated with Rotavirus and 56 (47.7%) children diagnosed with symptoms associated with Dysentery. Lastly, there were 57 (53.8%) children with symptoms associated with Rotavirus and 75 (63.6%) children with symptoms of Dysentery. In total 132 (58.9%) parents were not employed and 46 (20.5%) were employed.

Table 4: Shows the Crude Odds Ratios (COR) and Adjusted Odds Ratios (AOR) of study participants and Parents/guardians according to Diarrheoal Diseases

Characteristics	Responses	Crude Odds Ratios	95% Confidence Intervals	Adjusted Odds Ratios	95% Confidence Intervals
Age Group of Children	Less than 12 Months	**2.98**	**1.03 - 8.67**	0.31	0.09 – 1.04
	12-24 Months	1.39	0.69 - 2.79	0.53	0.23 – 1.27
	25-36 months	**Reference**	**Reference**	**Reference**	**Reference**
	37-48 Months	0.92	0.52 - 1.63	0.70	0.33 – 1.48
	49-60 Months	1.39	0.75 - 2.57	0.81	0.38 – 1.70
Gender of children					
	Male	0.83	0.55 - 1.25	1.18	0.75 – 1.84
	Female	**Reference**	**Reference**	**Reference**	**Reference**
Age of parent or guardian					
	Less than 20 years	0.77	0.36 - 1.6 3	1.05	0.33 – 3.28
	20 - 30 years	1.24	0.69 - 2.22	0.62	0.22 – 1.74
	31 - 40 years	**Reference**	**Reference**	**Reference**	**Reference**
	41 - 50 years	0.79	0.44 – 1.4	0.71	0.26 – 1.93
	51 - 60 years	0.81	0.41 – 1.59	0.83	0.29 – 2.31
	61+	0.87	0.37 – 2.04	0.84	0.28 – 2.45
Level of education of parent or guardian					
	Never attended	**8.33**	**4.08 – 16.97**	0.33	0.01 – 6.34
	Preschool	**5.78**	**1.57 – 21.20**	0.52	0.02 – 12.26
	Primary school	**2.36**	**1.17 – 4.73**	1.24	0.06 – 24.35
	Secondary school	2.13	0.94 – 4.81	1.35	0.06 – 27.13
	High school	**Reference**	**Reference**	**Reference**	**Reference**
	Tertiary education	1.23	0.44 – 3.49	2.88	0.14 – 57.18
	Elderly education	6.94	0.67 – 71.87	2.38	0.01 – 52.25
	Don't know	2.31	0.1 3 - 39.31	0.43	0.01 – 18.2018
Employment					
	Yes	0.95	0.57 – 1.58	1.63	0.80 – 3.32
	No	**Reference**	**Reference**	**Reference**	**Reference**
	Self employed	1.03	0.62 - 1.73	1.19	0.65 – 2.16

***Adjusted for age, gender, education level and employment status*

UNIVERSITY OF JOHANNESBURG

4.4 Crude Odds Ratios (COR) and Adjusted Odds Ratios (AOR) according to Demographic factors

The above table represents the Crude Odd Ratios (COR) and Adjusted Odds Ratios (AOR) of participants according to demographic factors. The odds ratios indicate that children with diarrheoa are 2.98 times more likely to be found in the age groups less than 12 months, with (COR: 2.98; 95% CI 1.03 - 8.67) indicating the results are statistically significant. Children with diarrheoal diseases in the study are 0.83 times less likely to be males with (COR: 0.83; 95% CI 0.55 – 1.25) with the results not statistically significant. Parents aged 20 – 30 years had the odds of 1.39 times more likely to have children that have diarrheoa (COR: 1.39; 95% CI: 0.69 – 2.79). This result was not statistically significant. On the level of education, parents who never attended school are 8.33 times more likely have children with diarrheoa with a odds ratio (COR: 1.39; 95% CI 4.08 – 16.97) than those who attended high school. Lastly parents who are employed are 0.95 times less likely to have children with diarrheoa with odds ratio (COR: 1.39; 95% CI 0.57 – 1.58) and the results are not statistically significant.

Table 5: Shows the Frequency Distribution of Study Participants and Parents/guardians by Water and Sanitation Factors

Characteristics	**Responses**	**TOTAL**		**Children with Diarrheoa**		**Children without Diarrheoa**	
		n	**%**	***n***	**%**	***n***	**%**
Sources of water	Borehole water	**70**	**17.9**%	13	5.8%	57	**34.1**%
	Protected spring water	19	4.9%	5	2.2%	14	8.4%
	Rainwater	71	18.2%	32	14.3%	39	23.4%
	Unprotected dug well	62	15.9%	48	21.4%	14	8.4%
	River water	169	43.2%	126	56.3%	43	25.7%
(Fecal coliform count results)							
	0 CFU's/100ml	70	17.9%	13	5.8%	57	34.1%
	11.29 CFU's/100ml	19	4.9%	5	2.2%	14	8.4%
	70.31 CFU's/100ml	71	18.2%	32	14.3%	39	23.4%
	1265.78 CFU's/100ml	62	15.9%	48	21.4%	14	8.4%
	1502.02 CFU's /100ml	169	43.2%	126	56.3%	43	25.7%
Is Drinking water treated?							
	Yes	140	35.8%	34	15.2%	106	63.5%
	No	251	64.2%	190	84.8%	61	36.5%

UNIVERSITY OF JOHANNESBURG

If yes, how do you treat water For cooking and drinking?	Boil water	57	35.6%	18	39.1%	39	34.2%
	Use jik/water Guard	103	64.4%	28	60.9%	75	65.8%
	Use ash	0	0	0	0%	0	0%
Container used to store water							
	Container inside the house with lid	270	69.1%	109	48.7%	161	96.4%
	Container or pocket inside the house without lead	94	24%	88	39.3%	6	3.6%
	Container of bucket outside the house with lid	3	0.8%	3	1.3%	0	0%
	Container or package outside the house without lid	24	6.1%	24	10.7%	0	0%
Type of toilet used							
	Water flush toilet	6	1.5%	5	2.2%	1	0.6%
	VIP toilet	167	42.7%	64	28.6%	103	61.7%
	Open pit latrine or traditional pit latrine	75	19.2%	41	18.3%	34	20.4%
	Bushes or forest	143	36.6%	114	50.9%	29	17.4%

4.5 Frequency Distribution by Water and Sanitation Factors

Parents/guardians of children were interviewed to determine their water and sanitation status. The first question was pertaining to their water sources that they use for fetching water for drinking and cooking. Most parents/guardians used river water for drinking and cooking 169 (43.2%) followed by water harvest or rainwater 71 (18.2%) and only 19 (4.9%) used protected spring water. Those who utilized river water for drinking had 126 (56.3%) children with diarrheoal diseases and those who used protected spring water had only 5 (2.2%) children with diarrheoa. Water samples from the identified sources were taken for laboratory analysis. Fecal coliform results for River water was 1502.02 CFU's/100ml, Borehole water was 0 CFU's/100ml, Rainwater was 70.31 CFU's /100ml, unprotected dug well water 1265.78 CFU's/100ml and protected spring water 11.29 CFU's/100ml

Parents/guardians who did not treat water before drinking were 251 (64.2%) and those who treated water were 141 (35.8%). Those who did not treat water before cooking or drinking had 190

UNIVERSITY OF JOHANNESBURG

(84.8%) children with diarrheoal diseases and those who treated water had 34 (15.2%) children with diarrheoa. Parents/guardians who treated water using jik/water guard pills were 103 (64.4%) and those who boiled water were 57 (35.6%). In terms of water storage, 270 (69.1%) used containers or buckets inside the house with a lid to store water for drinking while only 3 (0.8 %) used container of bucket outside the house with a lid.

The last question was on sanitation facilities used by parents/guardians of children and 167 (42.7%) responded that they used VIP toilets to dispose human waste while 36.6% (143) practiced open defecation in the forest and bushes. Those who practiced open defecation had 114 (50.9%) children with diarrheoal diseases and those who used VIP toilets had 103 (61.7%) children without diarrheoal diseases.

Table 6: Crude Odds Ratios (COR) and Adjusted Odds Ratios (AOR) of study participants and Parents/guardians according to Water and sanitation factors

Characteristics	**Responses**	**Crude Odds Ratios**	**95% Confidence Intervals**	**Adjusted Odds Ratios**	**95% Confidence Intervals**
Sources of water	Borehole water	0.64	0.19 - 2.09	**13.97**	**6.44 – 30.32**
	Protected spring water	**Reference**	**Reference**	**Reference**	**Reference**
	Rainwater	2.23	0.75 – 0.86	**10.52**	**3.19 – 34.76**
	Unprotected dug well	**9.60**	**2.94 – 31.30**	**2.88**	**1.50 – 5.55**
	River water	**8.20**	**2.7 9-24.11**	0.74	0.34 – 1.61
Fecal coliform count results					
	0 CFU's/100ml	0.64	0.19 – 2.09	**13.97**	**6.44 – 30.32**
	11.29 CFU's//100ml	**Reference**	**Reference**	**Reference**	**Reference**
	70.31 CFU's//100ml	**3.59**	**1.68 – 7.71**	**10.52**	**3.19 – 34.76**
	1265.78 CFU's//100ml	**15.03**	**6.4 4 - 35.06**	**2.88**	**1.50 – 5.55**
	1502.02 CFU's//100ml	**12.85**	**6.4 1 - 25.73**	**0.74**	**0.34 – 1.61**
Do you treat water for drinking and cooking?					
	Yes	**0.10**	**0.0 6 - 0.17**	**12.79**	**7.25 – 22.58**
	No	**Reference**	**Reference**	**Reference**	**Reference**
If yes, how do you treat water for cooking and drinking?					
	Boil water	1.24	0.6 1 - 2.50	0.63	0.22 – 1.75
	Use jik/water Guard	**Reference**	**Reference**	**Reference**	**Reference**

UNIVERSITY OF JOHANNESBURG

Type of toilet used	Water flush toilet	8.05	0.92 – 7.44	0.65	0.07 – 6.35
	VIP toilet	**Reference**	**Reference**	**Reference**	**Reference**
	Open pit latrine or traditional pit latrine	**1.94**	**1.12 – 3.37**	**6.89**	**3.87 – 12.27**
	Bushes or forest	**6.33**	**3.79 - 10.57**	**3.71**	**1.87 – 7.38**

**Adjusted for age, gender, education level and employment status*

4.6 Crude Odds Ratios (COR) and Adjusted Odds Ratios (AOR) according to Water and Sanitation factors

Table 6 shows Crude Odds Ratios (COR) and Adjusted Odds Ratios (AOR) of study participants and parents/guardians according to water and sanitation factors. Parents/guardians utilizing river and unprotected dug well are 8.20 and 9.60 times respectively likely to have children with diarrheoal diseases (COR: 8.20; 95% CI 2.79 – 24.11) and (COR: 9.60; 95% CI 2.94 – 31.30) respectively. These findings were statistically significant even when controlled for age, gender, education level and employment status, (AOR: 2.88; 95% CI: 1.50 – 5.55). Children who drink from water sources with 1265.78 CFU's/100ml are more likely to have diarrheoa with (COR:15.03; 95% CI 6.44 – 35.06). Parents/guardians who treated water before drinking are 0.10 less likely to have children with diarrheoal diseases with (COR: 0.10; 95% CI 0.06 – 0.17) when compared with those that did not treat water, with a more likely statistical significant (AOR: 12.79; 95% CI 7.25 – 22.58). Those who treated water using boiling method were 1.24 times more likely to have children with diarrheoal diseases with (COR: 1.24; 95% CI 0.61 – 2.50). Lastly parents/guardians who practiced open defecation have a 6.33 chance of having children with diarrheoal diseases during the study period with (COR: 6.33: 95% CI 3.79 – 10.57) showing statistically significant results.

UNIVERSITY OF JOHANNESBURG

Table 7: Frequency Distribution of Parents/guardians by Hygiene Practices

Characteristics	**Responses**	**TOTAL**		**Children with Diarrheoa**		**Children without Diarrheoa**	
		n	**%**	***n***	**%**	***n***	**%**
When do you wash your hands	After using the toilet	**72**	**18.4**%	25	11.2%	47	**28.1**%
	Before preparing food	22	5.6%	9	4%	13	7.8%
	Before eating	107	27.4%	40	17.9%	67	40.1%
	After cleaning child feces	28	7.2%	15	6.7%	13	7.8%
	After handling animals	3	0.8%	1	0.4%	2	1.2%
	Does not wash hands	159	40.7%	134	59.8%	25	15%

What do you use to wash your hands?							
	Running water and soap	90	23%	16	7.1%	74	44.3%
	Water in a basin and soap	86	22%	27	12.1%	59	35.3%
	Water in a basin and ash	7	1.8%	5	2.2%	2	1.2%
	Running water only	14	3.6%	12	5.4%	2	1.2%
	Water in a basin only	35	9.0%	30	13.4%	5	3%
	Don't wash hands	159	40.7%	134	59.88%	25	15.0%

4.7 Frequency Distribution of Parents/guardians of children by Hygiene Practices

This section interviewed parents/guardians of children about hygiene practices in their households. They were asked when they wash their hands and responded that 159 (40.7%) did not wash their hands at all most times, followed by those who washed their hands before eating 107 (27.4%). Parents/guardians who did not wash their hands had 134 (59.8%) children with diarrheoal diseases and those who washed their hands before eating had 67 (40.1%) children without diarrheoal diseases.

When asked on what they used to wash their hands 159 (40.7%) they reported that they did not wash their hands at all, followed by those who used running water and soap 90 (23%). Parents/guardians who did not wash their hands had 134 (59.88%) children with diarrheoal diseases.

UNIVERSITY OF JOHANNESBURG

Table 8: Crude Odds Ratios (COR) and Adjusted Odds Ratios (AOR) of Parents/guardians of children according to hygiene practices.

Characteristics	Responses	Crude Odds Ratios	95% Confidence Intervals	Adjusted Odds Ratios	95% Confidence Intervals
When do you wash your hands	After using the toilet	0.89	0.47 – 1.66	**13.32**	**6.23 – 28.44**
	Before preparing food	1.16	0.45 - 2.95	**10.17**	**3.44 – 30.08**
	Before eating	**Reference**	**Reference**	**Reference**	**Reference**
	After cleaning child feces	1.93	0.83 – 4.47	**11.77**	**6.03 – 22.96**
	After handling animals	0.84	0.07 – 9.53	**5.19**	**1.98 – 13.5 7**
	Does not wash hands	**8.98**	**5.03 – 16.02**	10.36	0.82 – 130

What do you use to wash your hands?	Running water and soap	**0.47**	**0.23 – 0.96**	**35.10**	**15.47 – 79.63**
	Water in a basin and soap	**Reference**	**Reference**	**Reference**	**Reference**
	Water in a basin and ash	5.46	0.99 – 29.96	**15.62**	**7.49 – 32.54**
	Running water only	**13.11**	**2.74 – 62.68**	1.14	0.173 – 7.60
	Water in a basin only	**13.11**	**4.58 – 37.48**	0.79	0.15 – 4.31
	Don't wash hands	**11.71**	**6.27 – 21.86**	1.12	0.34 – 3.67

**Adjusted for age, gender, education level and employment status*

4.8 Crude Odds Ratios (COR) and Adjusted Odds Ratios (AOR) according to hygiene practices

Table 8 shows Crude Odds Ratios (COR) and Adjusted Odds Ratios (AOR) of parents/guardians of children according to hygiene practices. The odds of having children with diarrheoa are 8.98 higher in parents/guardians who did not wash their hands with (COR: 8.98; 95% CI 5.03 – 16.02) when compared to those who washed their hands before eating. Parents/guardians who washed their hands with running water and soap are 0.47 times less likely to have children with diarrheoal diseases with (COR: 0.47; 95% CI 0.23 – 0.96) with a more likely statistically significant (AOR: 35.10; 95% CI 15.47 – 79.63). While, the odds of diarrheoa in children increased 13.11 times with parents/guardians who used water in a basin only to wash their hands with statistically significant odds ratio (COR:13.11; 95%CI 4.58 – 37.48).

UNIVERSITY OF JOHANNESBURG

Table 9: Frequency Distribution of Parents/guardians of children by knowledge of Diarrheoal diseases.

Characteristics	Responses	TOTAL		Children with Diarrheoa		Children without Diarrheoa	
		n	%	*n*	%	*n*	%
Do you know the Types of Diarrheoa	Yes	280	71.6%	153	68.3%	127	76%
	No	111	28.4%	71	31.7%	40	24%
Do you know the difference between dysentery and rotavirus?							
	Yes	110	28.1%	71	31.7%	39	23.4%
	No	281	71.9%	153	68.3%	128	76.6%
	No action	2	0.5%	2	0.9%	0	0%

What do you do if a family member has diarrheoa?	Buy medicine	7	1.8%	7	3.1%	0	0%
	Give ORS	148	37.9%	72	32.1%	76	45.5%
	Go to clinic or health facility	223	57%	136	60.7%	87	52.1%
	Go to traditional healer	11	2.8%	7	3.1%	4	2.4%
Diarrheoal diseases prevention knowledge							
	Do not know	30	7.7%	27	12.1%	3	1.8%
	Latrine usage	59	15.1%	33	14.7%	26	15.6%
	Covering food	59	15.1%	32	14.3%	27	16.2%
	Drinking clean water	22	5.6%	13	5.8%	9	5.4%
	Treating water	62	15.9%	31	13.8%	31	18.6%
	Store water safely	7	1.8%	6	2.7%	1	0.6%
	Prepare food properly	51	13%	29	12.9%	22	13.2%
	Wash hands with Water and soap	43	11%	25	11.2%	18	10.8%
	Going to traditional healer	58	14.8%	28	12.5%	30	18%
Signs and Symptoms of diarrheoa							
	Yes	369	94.4%	212	94.6%	157	94%
	No	22	5.6%	12	5.4%	10	6%

4.9 Frequency Distribution of Parents/guardians by knowledge of diarrheoal diseases

This was the last section, and parents/guardians were interviewed to determine their knowledge on diarrheoal diseases. First, they were asked if they knew the different types of diarrheoa and 280 (71.6%) knew the difference while 111 (28.4%) responded negatively. They were also asked if they knew the difference between Rotavirus and Dysentery, and 110 (28.1%) knew the difference while 281 (71.9%) did not know the difference.

Whenever a family member has diarrheoa, 223 (57 %) parents/guardians visit the clinic or health facility and only 11 (2.8%) opted for traditional healer. Those who visited the clinic or health facility had 87 (52.1%) children without diarrheoa diseases. Parents/guardians were asked how diarrheoal diseases can be prevented and 62 (15.9%) responded by saying water treatment can prevent diarrheoal diseases. Lastly, they were asked if they knew the symptoms of diarrheoal diseases, 369 (94.4%) knew the symptoms and 22 (5.6%) responded that they did not know the symptoms of diarrheoal diseases.

UNIVERSITY OF JOHANNESBURG

Table 10: Crude Odds Ratios (COR) and Adjusted Odds Ratios (AOR) of Parents/guardians of children according to knowledge of diarrheoal diseases.

Characteristics	Responses	Crude Odds Ratios	95% Confidence Intervals	Adjusted Odds Ratios	95% Confidence Intervals
Do you know the different types of diarrheoa?					
	Yes	**Reference**	**Reference**	**Reference**	**Reference**
	No	1.47	0.34 – 2.31	**1.85**	**1.11- 3.09**
Do you know the difference between dysentery and Rotavirus?					
	Yes	**1.91**	**1.18 – 3.10**	0.75	0.45 – 1.25
	No	**Reference**	**Reference**	**Reference**	**Reference**
What to do if a family member has diarrheoa?					
	Give ORS	**0.60**	**0.39 – 0.92**	2.56	0.61 – 10.87
	Go to clinic or health facility	**Reference**	**Reference**	**Reference**	**Reference**
	Go to traditional healer	1.12	0.32 – 3.93	1.24	0.29 – 5.14
Diarrheoal diseases prevention knowledge					
	Do not know	**6.48**	**1.70 – 24.68**	**0.14**	**0.0 4 – 0.58**
	Latrine usage	0.91	0.41 – 2.02	1	0.44 –2.26
	Covering food	0.53	0.38 – 1.88	0.95	0.44 – 2.19
	Drinking clean water	1.04	0.36 – 2.95	0.71	0.24 – 2.12
	Treating water	0.72	0.32 – 1.57	1.24	0.55 – 2.80
	Store water safely	4.32	0.78 – 39.06	0.16	0.01 – 1.62
	Prepare food properly	0.95	0.42 – 2.16	0.91	0.39 – 2.10
	Wash hands with Water and soap	**Reference**	**Reference**	**Reference**	**Reference**
	Going to traditional healer	0.67	0.30 – 1.49	0.77	0.31 – 1.93
Signs and Symptom of diarrheoa					
	Yes	**Reference**	**Reference**	**Reference**	**Reference**
	No	0.85	0.36 – 2.02	0.69	0.27 – 1.82

**Adjusted for age, gender, education level and employment status*

UNIVERSITY of JOHANNESBURG

4.10 Crude Odds Ratios (COR) and Adjusted Odds Ratios (AOR) according to knowledge of diarrheoal diseases.

The table above shows the Crude Odds Ratios (COR) and Adjusted Odds Ratios (AOR) of parents/guardians of children according to knowledge of diarrheoal diseases. Those who knew the difference between Rotavirus and Dysentery are 1.91 times more likely to have children with diarrheoa (COR: 1.91; 95%CI 1.18 – 3.10). The odds of diarrheoa in children whose parents/guardians use ORS when a member of the family have diarrhea are 0.60 times less likely with a statistically significant (COR: 0.60; 95% CI 0.39 – 0.92). Parents/guardians who do not know how to prevent diarrheoal diseases are 6.48 times more likely to have children with diarrheoa with statistically (COR: 6.48; 95%CI 1.70 – 24.68) with a less likely statistically significant (AOR: 0.14; 95% CI 0.04 – 0.58).

4.11 Conclusion

In this chapter, data analysis methods, study results and interpretation of the findings have been presented. Data findings in this chapter were presented as cross-tabulated data with the main outcome of the study. Crude and Adjusted Odds Ratios were conducted to determine the association between exposure and outcome in the study. In the next chapter, the implications of the main findings of the study will be discussed.

UNIVERSITY OF JOHANNESBURG

CHAPTER 5: DISCUSSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter presents the interpretation and discussion of the findings, conclusion and recommendations for the research study. Findings were compared with other studies and the strengths and limitation of the study discussed.

The primary objective of this study was to determine whether there is a relationship between diarrheoal diseases in children under-five years and water quality. The research was conducted at Madlenya community in Eswatini and the study participants were children under-five years of age. A pre-designed questionnaire was administered to parents/guardians to obtain data on the number of children under-five years with or without diarrheoal diseases and narrowed down to those who had been diagnosed with symptoms associated with Rotavirus and Dysentery during the study period. Data was analyzed using Statistical Package for the Social Sciences (SPSS) version 25, and EPINFO 7.2. This was the first study in Eswatini to be conducted on diarrheoal diseases in children under-five years, and it seeks to generate country-specific data that can be utilized to reduce children mortality resulting from diarrheoal diseases.

5.2 Study Objectives

1. To examine the relationship between diarrheoal diseases and children under-five years of age at Madlenya community
2. To investigate the relationship between diarrheoal diseases in children under-five years and drinking contaminated water at Madlenya.
3. To determine practices that impact water quality and the relationship between water quality and diarrheoal diseases in children under-five years at Madlenya.

5.3 Main Findings from the Study

The following are the main findings from the study, and they include results of interest in frequency distributions and those that showed statistical significance when the Crude and Adjusted odds ratio were conducted. They are grouped into 4 sections from the questionnaire. The period prevalence of diarrheoal diseases at Madlenya was calculated to be 57.27 per 100 children. The high prevalence of diarrheoal diseases in the community might have been compounded by the fact

UNIVERSITY OF JOHANNESBURG

that the study was conducted during the rainy summer season. In summer, as stated by Ikeda (2019) the wet conditions can lead to water sources contamination especially by fecal coliforms which are known to cause diarrheoal diseases.

5.3.1 Demographics

The study revealed that children under 12 months were statistically significantly more likely to have diarrheoal diseases (State the AOR and 95%CI). These findings are in concurrence with previous findings from studies conducted by Maphalala et al, (2017) in Eswatini, that Rotavirus infection was common among 0 – 11 months with a majority of the positives below the age of 2 years and another study by Melese at al, (2019) in Ethiopia. Both studies indisputably describe the reciprocate relation between diarrheoa diseases and age group in children. The increase prevalence of diarrheoa in this age group according to Gupta et al, (2015) can be attributed to the introduction of contaminated weaning foods, and that the child is mostly exposed to environmental conditions as it starts to crawl and walk and may ingest contaminated materials. Gupta et al, (2015) further explained that, as the age group increases the risk of diarrheoa decreases and this can be caused by the fact that the child then develops immunity to pathogens after repeated exposure.

Education provides parents or guardians of children with knowledge of proper hygienic practices, good feeding, weaning practices, recognition of diarrheoa symptoms and thus timely response to illnesses. Children, whose parents or guardians never attended school, were more likely to have diarrheoal diseases compared to those whose parents or guardians attended high school. A study by Aziz (2016) conducted in Malaysia reported results consistent with the findings of this study, where in they found that diarrheoa mostly occurred among children whose parents have no formal education or have primary school education. This cements the notion that diarrheoa and literacy are positively correlated.

Findings showed that 230 (58.8%) parents/guardians were not employed at all. This is not surprising as the unemployment rate in 2019 in Eswatini was estimated at 22.85 (World Bank, 2019). Employment of parents or guardians of children increases household income and decreases economic hardship and allow access to medication in times of illnesses. The correlation between employment status and diarrheoal diseases is well established and presented in several literature reviews that have examined a number of studies (Paul and Moser 2009). The results from this

study indicated that, parents who are employed are less likely to have children with diarrheoa. A study conducted in Sweden by Brydsten (2018) concurs with the study findings in that direct consequence of unemployment can be poverty and economic deprivation where income loss is likely to restrict healthy life choices. Water treatment options, medication, proper water storage containers, health baby foods, all require constant flow of income into the household to be maintained.

5.3.2 Water and Sanitation

5.3.2.1 Water Quality

Safe drinking water and basic sanitation is of crucial importance to the preservation of human health, especially among children. Water samples were taken from different water sources used by parents/guardians of children under-five years of age, and as a benchmark for analyses WHO water quality guidelines 2004 for domestic water were used. The water sources sampled are river water, borehole water, protected spring water, rainwater and unprotected dug well. WHO water-quality guideline value for domestic water use terms of *E. Coli* is 0 CFU's*/100 ml* water. *E. Coli* according to WHO (2018) is a type of bacteria that normal lives in human intestines and gut of some animals. Most type of *E. Coli* are harmless and can even aid with food digestion, however, some strains can cause diarrheoa if you ingest contaminated water and food.

UNIVERSITY OF JOHANNESBURG

5.3.2.2 Water Quality and Diarrheoal Diseases

The *E. Coli* results for each water source indicated that river water from Usuthu River was the most contaminated with *E. Coli* followed by water from unprotected dug well. The presence of E. Coli in water sources indicates that the water has been contaminated by fecal matter from warm bloodied animals like humans. The contamination of water sources by *E. Coli* can be directly linked to the fact that about 36% (143) parents/guardians of children practiced open defecation at Madlenya. River water is contaminated during rainy days as water from the fields and forest is channeled to rivers. Water harvest can be contaminated as wind blows dust containing fecal matter into corrugated iron sheets which collect rainwater and unclosed water tanks.

The study findings indicated that, parents/guardians utilizing river and unprotected dug well are more likely to have children with diarrheoal diseases, indicating statistically significant results

with unprotected dug well statistically significant even when adjusted for age, gender of children and level of education of parent or guardian. It can be deduced that drinking water from water sources at Madlenya community is independently associated with the occurrence of diarrheoa in children. The occurrence of diarrheoa in children increased gradually with type of water source risk of being contaminated by *E. Coli*. These findings are consistent with a study conducted in Ethiopia by Wasihgun (2017) which state that children who drank from unimproved sources of water were 3.7 times OR 3.7 95% CI (2.02 – 117.78) more likely to have compared to those who used improved water sources. Another study conducted by Abdiwahab et al, (2016) show results consistent with the study finding, as it states that the more the water source is unprotected the more chances of being contaminated with *E. Coli* bacteria which can cause diarrheoa in children. Another study by Levy (2015) stated that a meta-analysis study conducted by Gundry and others found no clear relationship between water quality and diarrheoa. However, interestingly when Gruber repeated the analysis with additional studies he found significant association between poor water quality and diarrheoa for studies that used *Escherichia Coli* as an indicator of microbial quality.

5.3.2.3 Water Treatment

Safe water supply has been proven to generally improve the lives of people, such as reduction of child mortality, reduction of poverty, improved productivity and longevity (Megersa, 2017). Parents/guardians who treated water before drinking are less likely to have children with diarrheoal diseases with odds ratio when compared with those that did not treat water, with statistically significant results even when adjusted for age, gender of child, education-level and employment status of parents. These findings are in contradiction with findings from a study conducted by Wasihgun (2017) which stated that household water treatment options were not found to be statistically significant in diarrheoa prevention. A possible explanation could be the storage conditions, and hygienic conditions of storage materials that could create the risk of recontamination of water after water treatment. However, the findings of this study are consistent with findings from Rwanda in Rusizi district by Sinharoy (2016) which suggest that appropriate water treatment of drinking water is important factor in reducing diarrheoa in children less than five years. Sinharoy's study is reflected in the study as parents/guardians who did not treat water before cooking or drinking had 84.8% (190) children with diarrheoal diseases and those who

UNIVERSITY OF JOHANNESBURG

treated water had 15.2% (34) children with diarrheoa indicating statistically significance of water treatment at household level.

5.3.2.4 Sanitation

Sanitation is a cornerstone for public health. Using proper toilets prevents the transfer of bacteria, viruses, and parasites found in human waste which contaminates water sources, soil and food. (WHO, 2008). Those who practiced open defecation had the highest number of children with diarrheoal diseases and those who used VIP toilets had the highest number of children without diarrheoal diseases. Parents/guardians who practiced open defecation had higher odds of having children with diarrheoal diseases during the study period. Evidence from observational and intervention studies suggest an association between sanitation and diarrheoal diseases, and these findings are consistent with studies conducted by Wolf et al, (2004) which compared improved sanitation and unimproved sanitation facilities. In addition, another study done in Bantern, Indonesia by Romahwati et al, (2007) discovered that mothers who defecated at latrines have fewer children with diarrheoa than mothers with who defecated at other places. An earlier study conducted in Burkina Faso showed that children whose mothers regularly dispose feces in latrines had an approximately 40% reduction in diarrheoa rate. The relationship between sanitation and diarrheoa at Madlenya can be explained by the fact that the presence of pit-latrines increases the chance of safe disposal of fecal matter which reduces the risk of contact between the causative of diarrheoa and parents and guardian of children.

UNIVERSITY OF JOHANNESBURG

5.3.3 Hygiene Practices

Parents/guardians who did not wash their hands had the highest number of children with diarrheoal diseases and those who washed their hands before eating had the highest number of children without diarrheoal diseases. The odds of having children with diarrheoa are higher in parents/guardians who did not wash their hands when compared to those who washed their hands before eating. A study carried out in Ethiopia by Wasihun (2018) had similar findings as it stated that mothers who wash their hands at critical times showed a remarkable difference occurrence of diarrheoa in children as compared to those who did not wash their hands. Another study conducted in Ethiopia by Gebru (2014) found that children with parents who practiced hand washing at critical times were 2.21 times more likely to concede to diarrheoa that those who did not. A case

control study by Nguyen (2006) demonstrated that hand-washing practice of mothers before food preparation was associated with lower risk of diarrheoa among children. Hand washing has been recommended by the WHO as it is important to prevent spread of diseases and germs among household members.

It is important to wash hands, after using the toilet, before preparing food, after cleaning a child (defecation), before breast-feeding and after handling of animals using the appropriate hand washing practices to prevent the spread of diarrheoal infections. Furthermore, the study revealed that, the odds of having diarrheoa in Madlenya increased with use of water in a basin only to wash their hands. The study findings are consistent with the already existing body of research and support the CDC (2020) recommendations to use soap to wash hands as an effective intervention for prevention of diarrheoal infections. Soap lifts soil and microbes from the skin and people tend to scrub hands more thoroughly when using soap, which further removes germs. In the current study, it was also observed that parents/guardians who washed hands with soap under running water had a higher number of children without diarrheoa, indicating that hand washing with soap and running water can significantly reduce the spread of diarrheoal diseases.

5.3.4 Diarrheoal Diseases Knowledge

The study findings indicate that, parents/guardians who knew the different types of diarrheoa had 68.3% (153) children with diarrheoa while those who responded negatively had 31.7% (71) children with diarrheoa. This indicates that there is no statistical relationship between knowledge of the types of diarrheoa with diarrheoa occurrence in children. This may be due to the fact that knowing the types of diarrheoa without knowing prevention measures cannot prevent the spread of diarrheoa. The study further explored knowledge of parent's knowledge of the prevention of diarrheoal diseases and revealed that, parents/guardians who do not know how to prevent diarrheoal diseases are more likely to have children with diarrheoa.

5.4 Research Limitations

The study adopted a cross-sectional design which is can only inform the researcher about associations but not causality. Thus, a more analytical study is needed to compliment this study. As the occurrence of diarrheoa was reported and immunization cards observed without the

confirmation of a doctor, the study might be affected by social desirability bias. In addition, the study used symptoms associated with Rotavirus and Dysentery which could introduce bias in terms of actual prevalence of these diseases. The study period which was 6 months might have introduced recall bias as parents or guardians were asked if there was any child with diarrheoa within the study period.

5.5 Strengths of the study

The research draws its strength from the fact that it is first study conducted on children under-five years old children in Madlenya community on diarrheoa and water quality thus it has the potential to provide baseline data for future studies. The pilot study was conducted in an area sharing similar characteristics with the study population thus the findings can be generalized to other communities with similar characteristics in the country.

5.6 Public Health Implications

The study will assist the Environmental Health Department in the formulation of informed policies on diarrheoa and children by filling identified gaps in the health system. This will lead to improvements in the overall health system planning process and eventually implementation strategies. By analyzing and implementing recommendations from the study diarrheoal diseases spread will be decreases thus mortality and morbidity especially in children. Public health implications at community and household level will include increased awareness and understanding of water quality, diarrheoal diseases, sanitation and the relationship between these variables. Households will understand the importance of water treatment, hygiene, water storage and the factors that could contribute to diarrheoal diseases in children. Lastly, the study will invoke the need to protect water sources by households and communities to improve water quality and prevent diarrheoal diseases.

5.7 Research Contributions

Although the research study could not explore fully all aspects of diarrheoal diseases and water quality, it has however, contributed to the countries health system directly or indirectly. Below are some of the areas where the research study has contributed.

UNIVERSITY OF JOHANNESBURG

a) Realization that government with implementing partners should strengthen programs to address the availability of safe drinking water, improved sanitation and health education in rural communities in the country first and upscale it to national level.
b) The study created awareness for the need for more investment and commitment to minimize the occurrence of childhood diarrheoa by designing and implementing strategies, formulating practical and comprehensive policies on parent's education on hygiene, water and sanitation.
c) Provision of country specific data on water quality and diarrheoal diseases in children which can be utilized to inform planning and target oriented policies.
d) Cementing knowledge on the association of age and diarrheoal diseases so that interventions and efforts can be focused on that particular age group.

5.8 Recommendations

The following are recommendations based on the findings of the study. The recommendations will help to guide Madlenya community, the Environmental Health Department in the Ministry of Health, and the country as a whole to better improve water and sanitation, hygiene, and health education policies in order to attain Sustainable Development Goals.

a) The community (Madlenya) should collaborate with relevant stakeholders, such as Department of Water Affairs, Ministry of Health to explore, identify and establish new water sources. This may entail the construction or rehabilitation of available water sources. Monitors should be established to ensure that all newly constructed or rehabilitated water sources adhere to Eswatini water quality standards.
b) Madlenya community should collaborate with the Ministry of Health and development partners to develop effective water treatment strategies. Further studies to understand the challenges community faces in effectively treating their water will provide insight into any future water-treatment solutions that will be viable with the aim to translate knowledge into practice.
c) Exploring integration of the water issues with other activities such as economic empowerment and self-help groups to aid fast tracking of identification and rehabilitation of protected water sources.

UNIVERSITY OF JOHANNESBURG

d) Conduct regular community campaigns on the importance and significant of hand washing with soap and water to improve practices. Consider supporting households to build hand-washing facilities using locally available materials (such as the tippy-tap).

5.9 Conclusions

The study revealed that poor sanitation, drinking water quality, hand washing without using soap before preparing children's food, and after visiting the toilet are major risk factors of diarrheoa in children under-five years of age. From the findings and correlations with existing research it can be concluded that there is a relationship between water quality and diarrheoal diseases in children. The more water is of poor quality the more likely those children will have diarrheoal diseases especially when drinking untreated water. Improved access to safe water supply and proper sanitation services to households would largely contribute to promoting the right to water and reduce morbidity and mortality especially of children. The findings from this study can be used to promote water treatment, sanitation and hygiene practices which are effective in preventing diarrheoa among children under the age of five-year. The study concludes that major improvements in water and sanitation, hygienic practices, impacting knowledge on diarrheoal diseases can significantly reduce diarrheoal diseases in children. Government has a huge task in the country to strengthen measures to improve drinking water quality to prevent diarrheoal diseases in children. More investments and efforts are to be redirected to diseases prevention to improve water and sanitation related diseases including diarrheoa. Additionally, there is need to formulate and strengthen health promotion activities especially in rural areas. The study has revealed that the knowledge of diarrheoal diseases in rural areas is limited and parents need to capacitate on health issues especially water quality and sanitation.

UNIVERSITY OF JOHANNESBURG

REFERENCES

Abdiwahab, H, Abera, K, Janvier, G. (2016). *Prevalence of Diarrheoa and Associated Factors among Under-Five Children in Jigjiga District, Somali Region, Eastern Ethiopia*. Med. 6(10):233–46.

All Africa. (2018). *Eswatini: Six Children Die in Eswatini in Diarrheoa Outbreak.* Available from: www. https://allafrica.com/stories/201809140303.html

Anteneh, Z., Andargie, K., Tarehegn, M. (2017). *Prevalence and determinants of acute diarrheoa among children younger than five years old in Jabithennan District, Northwest Ethiopia*. 17(1):99

Aziz, A, Ahmad, A. N., Razak, A. M., Omar, M., Kasim, M. N., Yusof, M., Sooryanarayana, R., Jamaludin, R. and Ying, Y. C. (2016*). BMC Public Health. Prevalence of and factors associated with diarrheoal diseases among children under five in Malaysia: a cross-sectional study*. 18(1). p.1863.

Bolarinwa, O., A. (2015). Principles and methods of validity and reliability testing of questionnaires used in social and health science researches. Nigerian postgraduate medical journal. 22 (4): 195-201

Boudreau, M., Gefen, D. & Straub, D. (2001). *Validation in Research: A State-Of-The-Art Assessment*. Mis Quarterly, 25, 1-24.

Brydsten, A. and Sebastian, S. M. (2018). *International Journal for Equity in Health. Health inequalities between employed and unemployed in northern Sweden: a decomposition analysis of social determinants for mental health*, 59(25).

Central Statistics Office. (2017). *the 2017 Population and Housing Census Preliminary Result*. Pdf.

Centre for Disease Control and Prevention. (2019a). *Downloads, Support, Epi Info*. Available at: https://www.cdc.gov/epiinfo/support/downloads.html

Centre for Disease Control and Prevention. (2019b). Rotavirus Symptoms. Available at: https://www.cdc.gov/rotavirus/about/symptoms.html

Centre for Disease Control and Prevention. (2018). Drinking water and Rota Virus. Available at: https://www.cdc.gov/healthywater/drinking/private/wells/disease/rotavirus.html

Centre for diseases Control. (2020). Show me the Science - How to Wash Your Hands. Available at: https://www.cdc.gov/handwashing/show-me-the-science-handwashing.html

UNIVERSITY OF JOHANNESBURG

Diersing, N. (2009). "Water Quality: Frequently Asked Questions." Florida Brooks National Marine Sanctuary, Key West, FL.

Eswatini Ministry of Health. (2018). Annual Budget Performance Report 2017-2018.Pdf.

Eswatini Ministry of Health. (2019). *Mission Statement.* Available from. http:// http://www.gov.sz/index.php/ministries-departments/ministry-of-health

Gaile, B. (2018). *Cross Sectional Study Advantages and Disadvantages*. Available at: https://brandongaille.com/15-cross-sectional-study-advantages-and-disadvantages

Gbru T, Tasha M, Kassahun W. (2014). *Risk factors of diarrheoal disease in under-five children among health extension model and non-model families in Sheko district rural community, Southwest Ethiopia: comparative cross-sectional study*.BMC Public Health. Pdf.

Getachew, A., Guadu, T., Tadie, A., Gizaw, Gebrehiwot, M., Cherkos, H. D., Menberu, A. M. and Gebrecherkos, T. (2018). *Diarrheoa Prevalence and Socio-demographic Factors among Under-Five Children in Rural Areas of NorthGondar Zone, Northwest Ethiopia*. Available from: https://www.hindawi.com/journals/ijpedi/2018/6031594/

Ghauri, P. & Gronhaug, K. (2005). *Research Methods in Business Studies*, Harlow, Prentice Hall

Government of Eswatini. (2015). The Second National Health Sector Strategic Plan 2014 – 2018. Towards attaining Universal Health care. Available from: http//www.gov.sz/index.php.Health - documents

Gupta, A., Sarker, G., Rout, J. A., Mondal, T. and Pal, R. A. (2015*). Journal of Global Infectious Diseases. Risk Correlates of Diarrheoa in Children under 5 Years of Age in Slums of Bankura, West Bengal*, 7(1), p.23-29.

Hayes, A. (2019). *Simple Random Sample Definition*. Available at: https://www.investopedia.com/terms/s/simple-random-sample.asp.

Ikeda, T., Kapwata, T. Swadhini, B., Minakawa. N, Hashizumi, M., Sweijid N. (2019). Climatic Factors in Relation to Diarrheoa Hospital Admission in Rural Limpompo South Africa. Atmosphere. 10 (552). 1-18

Jensen, K. P., Jayasinghe, G., Hoek, d. v. W. and Cairncross, S. (2004). Journal of Tropical Medicine. Is there an association between bacteriological drinking water quality and childhood diarrheoa in developing countries? 9(11)

UNIVERSITY OF JOHANNESBURG

Kakulu, K. (2012). *Diarrheoa among under-five children and household water treatment and safe storage factors in mkuranga district, tanzania*.pdf.

Khalili, M. (2014). *Acute Bacterial Dysentery in Children. International Journal of infection*. , 93(5)

Kingdom of Eswatini Government. (2014). *Service Availability Mapping Report 2013.* Available from: http://www.gov.sz/index.php/ministries-departments/ministry-of-health.

Kingdom of Eswatini Government. (2016). *Eswatini Multiple Indicator Cluster Survey. Final Report*. Documents. Available from: http://www.gov.sz/index.php/ministries-departments/documents/ministry-of-health. Pdf.

Kingdom of Eswatini Government. (2018). *Master Plan towards the Elimination of Neglected Tropical Diseases in Eswatini 2019*. Available from: http://www.gov.sz/index.php/ministries-departments/documents/ministry-of-health.Pdf.

Levy, K. (2015). *The American Journal of Tropical Medicine and Hygiene. Does Poor Water Quality Cause Diarrheoal Disease,* 93(5), 899- 900

Maphalala G, Phungwayo N, Masona G. (2018). Early impact of rotavirus vaccine in under 5 year old children hospitalized due to diarrhea, Eswatini. Vaccine. 36(47):7210-7214

Maphalala, G., Weldegebriel, G., Phungwayo, N., Ruhinda, E Lukhele, N., Tsegaye, G., Masona, G., Dube, N. N., Dlamini, N., Dlamini, A., Shabangu, P. and Khumalo, L. (2017). Science Journal of Public Health. Prevalence of Rotavirus in Under 5 Year Old Children Hospitalized for Acute Gastroenteritis, Eswatini, 5(4), p.353-358.

Megersa, O, D. (2017). Safe Drinking Water: Concepts, Benefits, Principles and Standards. Water Challenges of an Urbanizing World. 71352

Middleton, F. (2019). Reliability vs. validity. What is the difference? Available from: Http// www. scribbr.com/methodology/reliability-vs.- validity/

Ministry of Health. (2018). *Annual Performance report (2017-2018)*. Pdf

Ministry of Health. (2019). Second Quarter Performance Report. Available at. Http//www. Gov.sz/index.php/health-documents

Mokomane M, Kasvosve I, de Melo E, Pernica JM, Goldfarb DM. (2018). The global problem of childhood diarrheoal diseases: emerging strategies in prevention and management. *Ther Adv Infect Dis* ;5(1):29-43.

UNIVERSITY OF JOHANNESBURG

Nationl Health Sector Strategic Plan. (2008). Available from: http:// World Bank. Org. Documents. Pdf.

Nguyen, T.V, Van P, L, Huy, CL, Gia, KN, Weintraub, A. (2006). *Etiology and epidemiology of diarrheoa in children in Hanoi, Vietnam*. Int J Infectious Diseases.10:298–308.

Paul, K. I. & Moser, K. (2009). *Unemployment impairs mental health: Meta-analyses. Journal of Vocational Behavior*, 74, pp. 264-282.

Pennsylvania State University. (2019). Methods for Stress Management. Health Belief Model. Available from: https://psu.pb.unizin.org/kines082/chapter/the-health-belief-model/

Romahwati, N, et al. (2012*). Factors associated with diarrheoa among under-five children in Banten province Indonesia*. A secondary analysis of Indonesian national socio-economic survey 2007 and basic health research 2007: 26 .1.

Rotavirus Organization of Technical Allies. (2016). Rotavirus in Africa. Available from: http:// rotacouncil.org/wp-content/uploads/2016/10/Rotavirus-Vaccines-Africa-Factssheet

Sciencing. (2019). *The meaning of Sample Size*. Available from: http:// https://sciencing.com/meaning-sample-size-5988804.html

Setia, M, S. (2017). Methodology Series Module 3: Cross Sectional Studies. Indian Journal of Dermatologu. 61 (3): 261-264.

Singh, P. K. and Shrivastava, P. (2015). Analysis of water quality of River Narmada. International Journal of Current Research 7 (12). 24073-24076. http://www.journalcra.com/sites/default/files/12343.pdf.

Sinharoy, S.S, Schmidt W.P, Cox K, Clemence Z, Mfura L, Wendt, R. (2016). *Child diarrheoa and nutritional status in rural Rwanda: a cross-sectional study to explore contributing environmental and demographic factors. Tropical Medicine and International Health 2016*, 21 (8): 956–964.

Stewart, R. E. (2016). Agricultural technology: the effects of pollution. https://www.britannica.com/technology/agriculturaltechnology/The-effects-of-pollution.

Sumampouw, O.J, Nelwan, J. Rumayar, A.A. (2019). Socioeconomic Factors Associated with Diarrhea among under-fives children in Monado Coastal Area, Indonesia. Journal of Global Infectious Diseases. 11(4). 140-146.

UNIVERSITY OF JOHANNESBURG

Summit Medical Group. (2019*). Diarrheoa*. Available from: www.summitmedicalgroup.com/library/pediatric/health/hh diarrheoa.
Eswatini Draft National Water Policy. (2007). Department of Water Affairs. Pdf

The Eswatini Poverty Reduction Strategy and Action Plan. (2007). Available from: http://mindbank.info/item/2796.pdf.

Times of Eswatini. (2018). *Diarrheoa kills six kids*. Available from: http:// http://www.times.co.sz/news/120138-diarrheoa-kills-6-kids.html

UNICEF. (2019). *Water, Sanitation and Hygiene*. Available from. https://www.unicef.org/wash/

University of Rochester Medical Center. (2018). Rotavirus Infection in Children. Available at: https://www.urmc.rochester.edu/encyclopedia/content.aspx?contenttypeid=90&contentid=P0254

Vilane, B. R. T, Tembe, L. (2016). *Water Quality Assessment Upstream of the Great Usuthu River in Eswatini. Journal* of Agricultural Science and Engineering. 2, (6): 57-65.

Woldu, W., Bitew, D. B. and Gizaw, Z. (2016). *Tropical Medicine and Health. Socioeconomic factors associated with diarrheoal diseases among under-five children of the nomadic population in northeast Ethiopia,* 44(40),

World Health Organization. (2011a). *Water, sanitation and hygiene interventions and the prevention of diarrheoa*. Available from: https://www.who.int/elena/titles/bbc/wsh_diarrheoa/en/

World Health Organization (2011). Guidelines for Drinking Water Quality. 4th edition. Pdf.

World Health Organization. (2015). *World Health Organization Country Office Eswatini Biennial Report* (2014-2015). Available from: https://www.afro.who.int/sites/default/files/WHO%20Eswatini20Country%20Office%20Biennual%20Report%202014-2015.pdf

World Health Organization. (2017a). Diarrheoal disease. Available at: https://www.who.int/news-room/fact-sheets/detail/diarrheoal-disease

World Health Organization. (2017b). Water safety and quality. Available at: https://www.who.int/water_sanitation_health/water-quality/en/

World health Organization. (2018a). *Rotaviruses*. Available from: https://www.who.int/immunization/diseases/rotavirus/en/

UNIVERSITY OF JOHANNESBURG

World health Organization. (2018b). *Water, sanitation and hygiene interventions and the prevention of diarrheoa*. Available from: https://www.who.int/elena/titles/bbc/wsh

UNIVERSITY OF JOHANNESBURG

APPENDICES

Appendix 1: Higher Degree Committee Approval Letter

FACULTY OF HEALTH SCIENCES
HIGHER DEGREES COMMITTEE

MPH HDC-01-15- 2020

30 March 2020

TO WHOM IT MAY CONCERN:

STUDENT: NDZINISA, VM
STUDENT NUMBER: 218100015

TITLE OF RESEARCH PROJECT: The Relationship Between Water Quality and Diarrhoeal Diseases Namely Rotavirus and Dysentery in Children Under-five Years of Age in Madlenya Community, Eswatini

DEPARTMENT OR PROGRAMME: MASTER OF PUBLIC HEALTH

SUPERVISOR: PROF S FERESU **CO-SUPERVISOR:** -

The Faculty Higher Degrees Committee has scrutinised your research proposal and concluded that it complies with the approved research standards of the Faculty of Health Sciences; University of Johannesburg.

The HDC would like to extend their best wishes to you with your postgraduate studies

Yours sincerely,

Prof S Nalla
Chair: Faculty of Health Sciences HDC
Tel: 011 559 6258
Email: shahedn@uj.ac.za

Appendix 2: Research Ethics Committee Approval Letter

FACULTY OF HEALTH SCIENCES
RESEARCH ETHICS COMMITTEE

NHREC Registration: REC 241112-035

ETHICAL CLEARANCE LETTER
(RECX 2.1)

Student/Researcher Name	Vusi Mthulisi Ndzinisa	Student Number	218100015
Supervisor Name	Prof. S. Feresu	Co-Supervisor Name	N/A
Department	Environmental Health		
Qualification	MPH		
Research Title	THE RELATIONSHIP BETWEEN WATER QUALITY AND DIARRHEOAL DISEASES IN CHILDREN UNDER-FIVE YEARS OF AGE IN MADLENYA COMMUNITY, ESWATINI		
Date	6 June 2020	Clearance Number	**REC-260-2020**

Approval of the amended research proposal with details given above is granted, subject to any conditions under 1 below, and is valid until 6 June 2021.

1. Conditions*:
Gatekeeper permission, as required.
**Please note that failure to comply with the conditions above (if any) prior to implementation of the research will invalidate this ethical clearance.*

2. Renewal:
It is required that this ethical clearance is renewed annually, within two weeks of the date indicated above. Renewal must be done using the Ethical Clearance Renewal Form (REC 10.0), to be completed and submitted to the Faculty Administration office. *See Section 12 of the REC Standard Operating Procedures.*

3. Amendments:
Any envisaged amendments to the research proposal that has been granted ethical clearance must be submitted to the REC using the Research Proposal Amendment Application Form (REC 8.0) prior to the research being amended. Amendments to research may only be carried out once a new ethical clearance letter is issued. *See Section 13 of the REC Standard Operating Procedures.*

4. Adverse Events, Deviations or Non-compliance:
Adverse events, research proposal deviations or non-compliance must be reported within the stipulated time-frames using the Adverse Event Reporting Form (REC 9.0). *See Section 14 of the REC Standard Operating Procedures.*

The REC wishes you all the best for your studies.

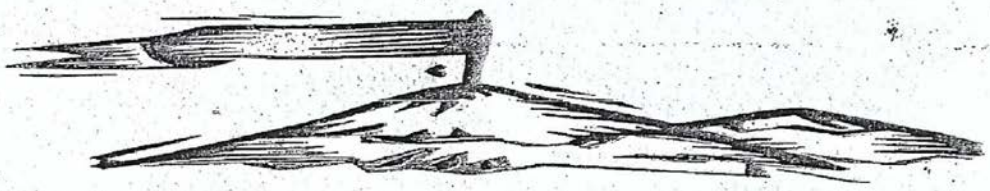
Yours sincerely.

Prof. Christopher Stein
Chairperson: REC
Tel: 011 559 6564
Email: cstein@uj.ac.za

RECX 2.1 – Faculty of Health Sciences
Research Ethics Committee

Secretariat: Ms Raihaanah Pieterse
Tel: 011 559 6073 email: rpieterse@uj.ac.za

Appendix 3: Research Approval Letter



Madlenya Royal Kraal
About 15 km From Siphofaneni
On the left hand side to St. Phillips
Next to Madlenya Evangelical Church
Before Madlenya Primary School

Madlenya Royal Kraal
P.O. Box 187
SIPHOFANENI

Date: ----------

23 January 2020

Mr Vusi Ndzinisa
Siphofaneni Clinic
P.O.Box 85 Siteki

Dear Ndzinisa

RE: REQUEST TO CONDUCT RESEARCH STUDY AT MADLENYA COMMUNITY

Madlenya community has received your request to conduct a research study at our community. The study is in fulfillment of the requirements of a Master's Degree in Public Health and its tittle is 'The Relationship between Water Quality and Diarrheoal Diseases namely Rotavirus and Dysentery in children Under-Five Years of Age in Madlenya Community, Eswatini.

Following a review of your proposal approval is hereby granted to conduct the research study at our community. We appreciate and acknowledge the benefits of the study to our community especially children who are the future of the country.

As a community, we would like to receive feedback after the completion of the study to help us plan the prevention of diarrheoal diseases.

Sincerely Yours

Indvuna/Headsman- Mfanyana Mgcamphalala

Contacts: 76242082

Appendix 4: Questionnaire

Questionnaire Number……

Date of Survey: ……. / ……/……

Name of Community……

Name of Data Collector……

Household Head Name……

Please answer all questions as truthfully and accurately as you can.

SECTION A: SOCIO-DEMOGRAPHICS

1) Age of child

≤ 12 Months	1
12 – 24 Months	2
25 – 36 Months	3
37 – 48 Months	4
49 – 60 Months	5
61+	6

2) Race of child

African	Asian	White	Mixed	Other
1	2	3	3	5

UNIVERSITY OF JOHANNESBURG

3) Gender of child

Male	1
Female	2

4) Does this household have other children?

Yes	1
No	2

5) How many children aged 0-5 years, currently live in this household? ☐

6) Are you the parent or guardian of child/children?

Parent	1
Guardian	2

7) Age of parent/guardian

≤ 20 Years	1
20 – 30 Years	2
31 – 40 Years	3
41 – 50 Years	4
51 – 60 Years	5
61+	6

8) Gender parent/guardian

Male	1
Female	2

9) Race of parent/guardian

African	Asian	White	Mixed	Other
1	2	3	3	5

10) How many people currently live (eat and sleep) in this household (including yourself)

☐

Education

11) What is the highest level of schooling you have completed?

Never attended	Preschool	Primary School	Secondary School	High school	Tertiary education	Adult Education	Don't Know
1	2	3	4	5	6	7	8

Occupation

12) Are you employed?

Yes	1
No	2
Self-Employed	3

SECTION B: WATER AND SANITATION

13) What is the main source of drinking water?

UNIVERSITY OF JOHANNESBURG

Piped into dwelling	Public water tap	Borehole	Protected spring	Purchased water	Rainwater collection	Unprotected dug well	River/ Stream
1	2	3	4	5	6	7	8

14) Are there times last month where water was unavailable from your main sources for a day or longer?

Yes	1
No	2

If your answer is YES to question 2, how many times was the water not available? ☐

15) Do you know any water treatment methods at household level?

Yes	1
No	2

16) If yes, what are they?

Boil	1
Jik /Chlorine / Water guard	2
Ash	3

Other……

UNIVERSITY OF JOHANNESBURG

17) Do you treat your water to make it safer for drinking and cooking?

Yes	1
No	2

18) If yes, how do you treat water?

Boil	1
Jik /Chlorine / Water guard	2
Ash	3

Other…….

19) If No, is there a reason why? .....

20) What kind of container does your household use to fetch and carry drinking water?

Container with lid	1
Container without lid	2

21) Where do you keep/store drinking water in your house?

Piped into dwelling	In a container/bucket inside the house with a lid	In a container/bucket inside the house without a lid	In a container / bucket outside the house with a lid	In a container/bucket outside the house without a lid
1	2	3	4	5

22) What type of toilet does your household use?

Water Flush toilet	VIP toilet	Open pit latrines/traditional pit	Other	No toilet, use bush or forest
1	2	3	4	5

23) If 5 what are the reasons for not having a toilet? .....

SECTION C: HYGIENE PRACTICES

24) When do you wash your hands?

After using a toilet	Before preparing food	Before eating	After cleaning child defecation	Before bread feeding a child	After handling of animals	Does not wash hands
1	2	3	4	5	6	7

25) What do you use to wash your hands?

Running water and soap	Running water and ash	Water in a basin and soap	Water in basin and ash	Running water only	Water in a basin only	Don't wash hand
1	2	3	4	5	6	7

UNIVERSITY OF JOHANNESBURG

SECTION D: DIARRHEOAL DISEASES KNOWLEDGE

26) Has any child had symptoms of diarrheoa (more than 3 loose watery stools in one day) in the past 6 months?

Yes	1
No	2
Don't Remember	3

27) If yes, please provide Clinical History card of Child

Acute Watery Diarrheoa	1
Bloody Diarrheoa	2

28) Did you seek treatment outside of home?

Yes	1
No	2
Don't Remember	3

29) If yes, where did you seek treatment?

Government health facility/clinic/hospital	Private Doctor	Traditional Healer	Religious Leader	Community Health Worker
1	2		3	4

Other……

30) Do you know the types of diarrheoa in children?

Yes	1
No	2

31) If yes, can you differentiate between Rotavirus and Dysentery?

Yes	1
No	2

32) Do you know the signs and symptoms of diarrheoa in children?

Yes	1
No	2

UNIVERSITY OF JOHANNESBURG

33) What do you usually do when a member of the family is having diarrheoa?

No action	Buy medicine	Stop feeding	Give ORS	Continue feeding	Go to clinic	Go to traditional healer
1	2	3	4	5	6	7

Other……

34) How do you think diarrheoa can be prevented?

Do not know	Latrine use	Covering food	Drink clean water	Treating water	Store water safely	Prepare food properly (cooking, washing)	Wash hands with water and soap/ash	Going to the tradition healer
1	2	3	4	5	6	7	8	9

Others, specify……

Thank you for participating in the study.

Appendix 5: Research Consent Form REC 11.0

UNIVERSITY OF JOHANNESBURG

DEPARTMENT OF HEALTH SCIENCES

RESEARCH CONSENT FORM

REC 11.0

The relationship between water quality and diarrheoal diseases in children under-five years of age in Madlenya community, Eswatini.

Please initial each box below:

☐ I confirm that I have read and understand the information letter dated Click here to enter the date, as is appears on the information sheet. For the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.

☐ I understand that my participation is voluntary and that I am free to withdraw from this study at any time without giving any reason and without any consequences to me.

☐ I agree to take part in the above study.

_____	_____	_____
Name of Participant	Signature of Participant	Date
_____	_____	_____
Name of Researcher	Signature of Researcher	Date

Appendix 6: Information letter Rec 11.0

DEPARTMENT OF HEALTH SCIENCES

RESEARCH STUDY INFORMATION LETTER

REC 11.0

4 November 2019

Good Day

My name is Vusi M Ndzinisa **I WOULD LIKE TO INVITE YOU TO PARTICIPATE** in a research study on the relationship between water quality and diarrheoal diseases in children under-five years of age in Madlenya community, Eswatini.

Before you decide on whether to participate, I would like to explain to you why the research is being done and what it will involve for you. **I will go through the information letter with you and answer any questions you have.** This should take about 20 minutes. The study is part of a research project being completed as a requirement for a Master's Degree in Public Health through the University of Johannesburg.

THE PURPOSE OF THIS STUDY is to determine the relationship between water quality and diarrheoal diseases in children under-five years of age in Madlenya community.

Below, I have compiled a set of questions and answers that I believe will assist you in understanding the relevant details of participation in this research study. Please read through these. If you have any further questions, I will be happy to answer them for you.

DO I HAVE TO TAKE PART? No, you do not have to. It is up to you to decide to participate in the study. I will describe the study and go through this information sheet. If you agree to take part, I will then ask you to sign a consent form.

WHAT EXACTLY WILL I BE EXPECTED TO DO IF I AGREE TO PARTICIPATE? You will be expected to answer a number of questions from a questionnaire.

WHAT WILL YOUR RESPONSIBILITIES BE, AS THE RESEARCHER? The researcher will ensure that all questionnaires are filled by Rural Health Motivators.

APPROXIMATELY HOW LONG WILL MY PARTICIPATION TAKE? Your participation will take approximately 20 minutes.

WHAT WILL HAPPEN IF I WANT TO WITHDRAW FROM THE STUDY? If you decide to participate, you are free to withdraw your consent at any time without giving a reason and without any consequences. If you wish to withdraw your consent, you should inform me as soon as possible.

IF I CHOOSE TO PARTICIPATE, WILL THERE BE ANY EXPENSES FOR ME OR PAYMENT DUE TO ME? You will not be paid to participate in this study and you will not bear any expenses.

IF I CHOOSE TO PARTICIPATE, WHAT ARE THE RISKS INVOLVED? There are absolutely no risks involved, your information will be kept confidential.

IF I CHOOSE TO PARTICIPATE, WHAT ARE THE BENEFITS INVOLVED? There are no direct benefits; however, the study may help prevent the spread of diarrheoal diseases in your community

WILL MY PARTICIPATION IN THIS STUDY BE KEPT CONFIDENTIAL? All reasonable efforts will be made to keep your personal information confidential and respect your right to privacy. This includes replacing your identifying personal information with a number that only I or my research supervisor will know. You will not be identified in any research reports that are published. Under some circumstances, such as when required to do so by a court of law, I may have to disclose your personal information. In addition, it may happen that your information will need to be reviewed by another organization for quality assurance purposes. I will tell you about this if it happens.

Click here to enter any other information about confidentiality specific to your research, if applicable.

UNIVERSITY OF JOHANNESBURG

WHAT WILL HAPPEN TO THE RESULTS OF THE RESEARCH STUDY? The results will be written into a research report that will be assessed. In some cases, results may also be published in a scientific journal. In either case, you will not be identifiable in any documents, reports or publications. You will be given access to the results of this if you would like to see them, by contacting me.

WHO IS ORGANISING AND FUNDING THIS RESEARCH STUDY? The study is being organized by me, under the guidance of my research supervisor at the Department of Health Sciences at the University of Johannesburg. This study will be funded by me.

WHO HAS REVIEWED AND APPROVED THIS STUDY? Before this study was allowed to start, it was reviewed in order to protect your interests. This review was done first by the Department of Environmental Health, and then secondly by the Faculty of Health Sciences Research Ethics Committee at the University of Johannesburg. In both cases, the study was approved.

WHAT IF THERE IS A PROBLEM? If you have any concerns or complaints about this research study, its procedures or risks and benefits, you should ask me. You should contact me at any time if you feel you have any concerns about being a part of this study. My contact details are:

Vusi Mthulisi Ndzinisa

+268 76385495

nnndozo@yahoo.com

You may also contact my research supervisor:

Professor Shinga Feresu

sferesu@gmail.com

If you feel that any questions or complaints regarding your participation in this study have not been dealt with adequately, you may contact the Chairperson of the Faculty of Health Sciences Research Ethics Committee at the University of Johannesburg:

Prof. Christopher Stein

Tel: 011 559-6564

Email: cstein@uj.ac.za

FURTHER INFORMATION AND CONTACT DETAILS: Should you wish to have more specific information about this research project information, have any questions, concerns or complaints about this research study, its procedures, risks and benefits, you should communicate with me using any of the contact details given above.

UNIVERSITY OF JOHANNESBURG

Researcher:

Vusi Mthulisi Ndzinisa

Appendix 7: Editors Certificate

EDITING/PROOFREADING CONFIRMATION

To whom it may concern

Tis serves to certify that I **Dr. Thenjiwe Sisimayi (Ph.D.)** have proofread and/or edited **Vusi Mthulisi Ndzinisa**'s Masters Dissertation to ensure that the language, grammar, punctuation and spelling are academically sound and appropriate, by rectifying errors, wherever these have been identified, and rephrasing sentences that would possibly make one lose sight of the flow of the argument.

Title of the Dissertation:	**The Relationship Between Water Quality and Diarrheoal Diseases In Children Under-Five Years Of Age In Madlenya Community, Eswatini**
Editor's name:	**Dr. Thenjiwe Sisimayi (Ph.D.)**
Qualification:	**PH.D. in Public Health**
Signature	
Date:	12. July 2020

UNIVERSITY OF JOHANNESBURG

Appendix 8: Turnitin certificate

turnitin

Digital Receipt

This receipt acknowledges that Turnitin received your paper. Below you will find the receipt information regarding your submission.

The first page of your submissions is displayed below.

Submission author:	VM NDZINISA
Assignment title:	D3 Minor Dissertation I: Turnitin Ass…
Submission title:	Mini Dissertation. Ndzinisa
File name:	Mini_Dissertation._Ndzinisa-revised…
File size:	4.91M
Page count:	93
Word count:	23,304
Character count:	141,360
Submission date:	02-Aug-2020 12:29PM (UTC+0200)
Submission ID:	1364971571

University of Johannesburg

Faculty of Health Science

UNIVERSITY OF JOHANNESBURG

Copyright 2020 Turnitin. All rights reserved.

Appendix 9: Timeline for the Study

PROJECT ACTIVITY	2019-2020 June 2019-April 2020											Person Responsible
Months	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**	
Questionnaire finalization												**RESEARCH TEAM**
Ethical approval												
Study Area preparation												
Recruitment of data collectors												
Training of data collectors												
Identification of sample size												
Commencement of data collection												
Data interpretation												
Report Writing												
Submission of final research document												
Publishing of Research study												

UNIVERSITY OF JOHANNESBURG

Appendix 10: Budget

CATEGORY AND ITEM		ROLE	TIME FRAME	DAILY RATE (R)	TOTAL COST (R)
Personal Wages	1 x Research assistant	To assist main researcher	June - Jan 2019	R 20/ day	**R 4000.00**
	1 x Consultant	Consultations on research	Upon request	R 200	**R 1000.00**
	8 x interviewers	To interview study participants	30 days	R 20	**R 2400.00**
Material and supplies	1 x laptop	To be used to input collected data	June - Jan 2019		**R 5500.00**
	Water samples bottles	To collect water samples for analysis	June - Jan 2019		**R 950.00**
	Stationary	Exercise books, pens , and rulers	June - Jan 2019		**R 750.00**
	Questionnaire forms Printing and photocopying	Capture data	June - Jan 2019		**R 830.00**
	Publication Cost	Cost of publishing the Research Study			**R 400.00**
	1 x GPS Device	To map water sources	June - Jan 2019		**R 1200.00**
	GIS software	To input collected geographical data	June - Jan 2019		**R 300.00**
Transport	Bus Fare (Researcher)	For transport to and from study area	June - Jan 2019	R 20/day	**R 470.00**
	Travel for consultation	To consult on research	Occasionally		**R 360.00**
	Field work travel for interviewers	To collect data from study participants	June - Jan 2019		**R 2000.00**
	Community meetings transport	Meeting to introduce research project			**R 410.00**
Other	Meals for interviewers and researchers	Food supplies	Data collection stage	R 20/day	**R 700.00**
	Internet Cost	For researching and communication	June - Jan 2019	R 100.00/ month	**R 1200.00**
	Meetings Venue	Meetings			**R 200.00**
	Airtime (interviewers and Researchers)	communication	June - Jan 2019	R10.00/day	**R 1310.00**
	Laboratory Fees	Analysis of Water Samples			**R 250.00**
				Total	**R24230.00**

The total budget for the study was estimated to be R24230.00.

UNIVERSITY OF JOHANNESBURG